DISEASE RESPONSE STRATEGY

Logistical details for the National Elk Refuge response to the detection of Chronic Wasting Disease in the Jackson Elk Herd Unit

Contents

Introduction

Chronic wasting disease (CWD) is a disease of the nervous system that affects cervids, including deer, elk, caribou and moose. Caused by a prion, or abnormal protein, CWD causes degeneration of the nervous system. As the disease progresses, the animal begins to display abnormal behavior, weight loss, and loss of control of normal bodily functions. There is no known treatment or cure. Animals may show no visible signs of illness for a year or more after infection, such that deer, elk, caribou or moose may be infected and shedding the prion even if they look healthy. CWD is contagious, with infectious prions passed between animals and also from contaminated environments (including plants and soil) that accumulate prions over time. Prions are difficult to remove and environments may remain infectious for many years.

First identified as a disease in deer in a Colorado captive facility in 1967, CWD was identified as a transmissible spongiform encephalopathy (TSE) in 1978. CWD now affects cervids in 25 states and 3 Canadian provinces and continues to spread each year; as of November 2018, CWD was detected in a mule deer within the bounds of the Jackson Elk herd unit. To date, the closest CWD detection elk is approximately 140 miles east of NER.

Nature of the disease

Prions are proteins that normally occur on the membranes of cells, but abnormal, resistant forms accumulate in the nervous system causing neurodegenerative disease. TSEs are caused by abnormally folded, resistant forms (PrP^{res}) of the normal host prions (PrP^{c}). Chronic wasting disease is a fatal TSE that occurs as a result of the CWD-specific abnormal prion identified as PrP^{cwd}.

Host species

- White-tailed deer
- Black-tailed deer/ mule deer
- Elk
- Moose
- Caribou/reindeer

Transmission

The spread of CWD occurs directly through direct contact between free-ranging animals, via movements of captive animals between fenced facilities, or it can occasionally arise spontaneously as a result of protein mis-folding. Horizontal animal-to-animal transmission is very efficient and is likely a significant driver of disease transmission early in an outbreak.

CWD also spreads indirectly via PrP^{cwd} shed in feces, urine, and saliva, as well as decomposing carcasses. Prions have also been detected in plant tissues, such that plant material may serve as an environmental reservoir in addition to soils. The prions are very stable in the environment, which remains infectious for many years.

Prevalence of infection, morbidity and mortality

In free-ranging cervids, estimated prevalence in core endemic areas has varied from year to year. The prevalence of CWD in white-tailed deer harvested in the Wyoming Game and Fish Department (WGFD) hunt area (65) was 32% in 2003 and 43% in 2010, and 33% (n = 132) overall during the study period (2003–2010; WGFD, unpublished data). In the South Converse Mule Deer Herd Unit, CWD prevalence in mule deer was 42.9% for 2016 (Wyoming WGFD 2016 CWD Surveillance Report). In the Laramie Peak Elk Herd Unit, the 2016 CWD prevalence in elk was 5.9% and the 2012-2016 average CWD prevalence in elk was 6.4% (Wyoming WGFD 2016 CWD Surveillance Report).

Once infected, it takes about 16 months for the animal to appear ill, although the animal likely sheds infectious CWD prions in feces, saliva and urine for most of the disease course. Death often occurs within 2 years after infection.

Animals appear healthy until the later stages of the disease and clinical signs alone are not diagnostic of CWD.

- Weight loss
- Decreased social interaction, loss of awareness
- Tooth grinding
- Altered posture (head and ears lowered, wide-based stance)
- Head tremors
- Incoordination
- Increased drinking
- Excessive salivation
- Increased urination
- Aspiration pneumonia

Differential diagnosis

Because the clinical signs listed above may be seen in association with other diseases, it is important to keep in mind that other diseases such as epizootic hemorrhagic disease, bluetongue, brain abscesses, and toxicity may cause clinical symptoms similar to CWD, and may therefore be indistinguishable from CWD without laboratory diagnostics.

Occurrence

Chronic wasting disease is currently found in Canada, the United State, South Korea, Norway, and Finland. See the following website for the latest map of CWD in North America: https://www.usgs.gov/centers/nwhc/science/expanding-distribution-chronic-wasting-disease?qt-science_center_objects=0#qt-science_center_objects

Laboratory diagnosis

- Diagnosis of CWD requires laboratory testing for the detection of PrP^{cwd} in the medial retropharyngeal lymph nodes or the brain stem (obex), collected post-mortem. Our current protocol in collaboration with WGFD is for RNL as the primary sample.
- Post-mortem diagnostic tests:
    - Immunohistochemistry (IHC) – gold standard, place the obex and retropharyngeal lymph nodes in a 10% buffered formalin jar (10:1 ratio of formalin to tissue sample), ship the samples in formalin jars.
    - Enzyme-linked immunosorbent assay (ELISA) – screening test, place the fresh obex sample and retropharyngeal lymph nodes in whirl-pak bags, keep samples chilled on icepacks. Ship using overnight delivery. Frozen samples are also acceptable if packing precautions are made to ensure that the samples remain frozen until delivery to the laboratory.
    - Protein misfolding cyclic amplification (PMCA) and Real time quaking-induced conversion (RT-QuIC) are new diagnostic amplification techniques that are used in research but not yet applied in the field for surveillance.
- Ante-mortem diagnostic tests:
    - Although live-animal sampling techniques have been developed using rectoanal mucosa-associated lymphoid tissue (RAMALT) and tonsilar biopsy, these specialized techniques are difficult to perform and have a much lower rate of success in detecting CWD.

Resistance to physical and chemical action

- Prions can remain in the soil for several years and are resistant to inactivation by most chemical agents, radiation, and moderate heat
- Only a few disinfectants inactivate prions, these include CIP100, HOCl and bleach
- Incineration in an incinerator capable of exceeding 1000°C (1832°F), alkaline digestion in specially designed equipment, and disposal in certified municipal landfills are used for disposal of tissues and carcasses of animals with CWD.

Prevention

Because CWD is difficult to manage in free-ranging populations, disease prevention is critical. Preventive measures include:

- Basic epidemiological principle: prevent transmission of PrP^{cwd} from infected to susceptible animals
    - Prevent infected animals from coming in contact with susceptible animals
    - Prevent infected animals from contaminating CWD-free areas
    - Prevent contact between susceptible animals and CWD-contaminated areas
- In practice, this means:

    - Reducing our reliance on supplemental feeding to decrease artificial congregations of animals that enhance CWD transmission. Ways to reduce disease risk associated with feeding:
        - Decrease the length of feeding season
        - Continue spreading out the feed spatially to distribute animals more thinly and decrease animal contact
    - Restricting or banning the importation of live cervids into CWD-free areas
    - Whole-herd disease monitoring within game farms with depopulation or test and cull
    - Banning hunters from bringing whole carcasses, or any nervous system materials, into their home states
- A Bison and Elk Management Plan was finalized in April 2007 with the signing of the Record of Decision. This 15-year plan guides management of both species for both the National Elk Refuge and Grand Teton National Park. The Bison and Elk Management Plan has two primary purposes. They are: Providing managers with goals, objectives, and strategies for managing bison and elk on the National Elk Refuge and in Grand Teton National Park for the next 15 years, in support of the purposes for which two areas were established; and Contributing to the missions and management policies of the U.S. Fish and Wildlife Service and the National Park Service. Details on elk management that may be relevant to the potential introduction and transmission of CWD in the Jackson elk herd may be found here: https://www.fws.gov/bisonandelkplan/

Treatment

There are no treatments or vaccines available for CWD.

Actions recommended at NER prior to CWD detection

Communication with partners and stakeholders

- Share updated NER plans with state, federal, and other partners.
  These include: Wyoming Game and Fish Department, Grand Teton National Park, Yellowstone National Park, U.S. Forest Service, Wyoming Migration Initiative, University of Wyoming USGS Co-op Unit, USGS Northern Rocky Mountain Science Center, Wyoming Department of Transportation, Teton County, Idaho Department of Fish and Game and Montana Department of Game, Fish, and Parks, Wyoming Public Health Department, and Teton County Public Health Department.
- Ensure regular intra- and interstate CWD coordination meetings. Engage agriculture and public health departments.
- Maintain up to date contact information for key individuals.
- Continue to facilitate the connections between WGFD, NER, and GRTE public information officers prior to the CWD detection.

Public outreach prior to detection

Public outreach with the local community should be conducted by FWS external affairs and public information experts in collaboration with public information officers from other agencies before CWD is detected on the Refuge to prepare people for the impacts CWD will have on animal health and the actions the Refuge will be taking in response to the disease introduction.

Products to be developed or updated:

- Talking points for WGFD, FWS, and NPS to use for consistency in messaging
- Pre-approved fact sheets
- Press releases
  - Highlight collaboration of the agencies on CWD surveillance (e.g., each agency is doing opportunistic surveillance of road kill elk/deer/moose and to a greater or lesser extent of wolf killed elk/deer as well as animals found dead for other reasons).
  - Highlight that the response to CWD once it is in the Jackson area will be coordinated and all agencies will be involved.
  - Prepare a joint press release (e.g., WGFD/NER or NPS) if the first case is found on NER or NPS to speed the approval process
- Refuge website information
- Facebook, twitter, and other social media updates
- Town hall meetings
- Public information plan for CWD positive confirmation at NER
- Hunt brochure with information about CWD transmission routes
- Prepare a one-pager for the visitor center staff to hand to the public in response to questions regarding CWD clinical signs

Training needs prior to detection

Training for the following is available through the Wildlife Health office:

- Recognition of CWD clinical signs
- Humane euthanasia techniques – see printed guidelines below and https://sites.google.com/a/fws.gov/fws-wildlife-health/animal-welfare
- Collecting and shipping CWD samples for testing
    - WGFD guidance on website, https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Wildlife-Disease/CWD-in-Wyoming-Wildlife/CWD-Testing
- Carcass handling
- Biosecurity and biosafety
- Incinerator operation

Training for the following is available through the DOI Office of Emergency Management

- Incident Command System training for Refuge staff (all courses below are available on-line)
    - Introduction to the ICS, ICS-100 (IS-100.b)
    - ICS for Single Resources and Initial Action Incidents, ICS-200 (IS-200.b)
    - NIMS, An Introduction (IS-700.a)
    - NRF, An Introduction (IS-800.b)

Equipment and supplies needed prior to detection

- Incinerator meeting specific temperature specifications (reaches temperatures exceeding 1000°C (1832°F)).
    - Dedicated equipment for getting animals to and into the incinerator
    - Dedicated equipment for clearing and disposal of ashes
    - Generator
    - Fuel supply
- Dedicated enclosed transport for carcasses off-refuge
- *Cleaning* supplies to remove (but not disinfect) potentially infectious material from equipment – wash station for vehicle and trailer, scrub brushes, boots, buckets, waterproof aprons, hot water
- *Disinfection* of CWD prions involves special chemicals and processes, some of which are caustic and may damage equipment. Although HOCl has recently been identified as effective in prion disinfection, studies have not yet been conducted on various types of equipment.

Agreements, contracts, and permits that need to be in place prior to detection

- The EPA currently recommends using municipal solid waste landfills for the large-scale disposal of potentially CWD-contaminated carcasses and wastes. This is currently not an option due to capacity problems at the Teton landfill.
- The Association of Fish and Wildlife Agencies (AFWA) recommends using high temperature incineration for the disposal of potentially CWD-contaminated carcasses and wastes. Permits may be required for burning. See: https://www.fishwildlife.org/application/files/5215/3729/1805/AFWA_CWD_BMPS_12_September_2018_FINAL.pdf and https://www.fishwildlife.org/application/files/9615/3729/1513/AFWA_Technical_Report_on_CWD_BMPs_FINAL.pdf
- Agreement or contract with a local landfill to accept incinerator bottom ash is recommended.
- To accommodate the increase in both prevalence and geographic spread that will occur after detection of CWD, a regional carcass disposal plan should be developed in partnership with key partners and stakeholders.

Feeding

- Preferred option with regards to feeding:
    - Reducing our reliance on supplemental feeding to decrease artificial congregations of animals that enhance CWD transmission.
    - Request to revisit the existing Bison and Elk Management Plan to change to state's elk population objectives

Habitat

- Consider cost/benefit of habitat and forage enhancement on the refuge relative to artificially concentrating animals and creating potentially highly contaminated areas on the refuge.

Laboratory testing

- Discuss with diagnostic laboratories their capacity to test increased numbers of CWD samples, any changes in submission protocols
- Samples that unexpectedly exceed existing laboratory capacity may be submitted through Wildlife Health office CWD testing contract with Colorado State University
- Determine whether contracts and associated funds need to be put in place prior to detection

Incident Command

- Work with the Wildlife Health office to identify qualified command and general staff willing to work with NER in preparation for CWD introduction

Data sharing

- Informal sharing practices are already in place between WGFD, FWS, NPS

Response to the introduction of CWD to any cervid within the Jackson Elk Herd Unit

Strategy for responding

One basic epidemiological principle serves as the foundation for a response to CWD at the National Elk Refuge: Limit transmission of PrP^{cwd} to susceptible animals and limit contamination of new geographic areas to the greatest extent possible. These actions are taken in an effort to minimize the population impacts of CWD on wildlife utilizing the refuge.

Case definitions

- *Suspect case* – an animal with clinical signs consistent with CWD
- *Presumptive positive case* – an animal testing positive for CWD by the screening test (ELISA)
- *Confirmed positive case* – an animal testing positive for CWD by the gold standard test (IHC) (additional samples may not always be available for confirmatory testing, and secondary level testing of samples by ELISA may serve as confirmation)

Reporting

Laboratory reports to NER, National Park Service, and local WGFD Brucellosis feed ground manager
NER notifies the partners listed on page 1 of this plan.

Critical activities

Triggers

- Presumptive Positive CWD detection in any cervid within the Jackson Elk Herd Unit
- New information released by CDC concerning increased public health risk associated with CWD in animals and the environment

Stand up incident command

- R6 Regional Office declares a formal Incident
    - Triggers
        i. Refuge capacity exceeded by the outbreak
        ii. CWD is confirmed as a risk to human health
    - Wildlife Health incident response team – ready team of folks experienced with incident command and wildlife health emergencies. This would provide an Incident commander, Public information officer, Safety officer, Veterinarian, Operations branch (monitoring dispersal of animals from the refuge, symptomatic animal response, carcass detection and disposal; sample collection for epi projects)

Define zones

- Initial Response Area
    - The initial response area will be defined by the boundaries of the refuge when a Presumptive Positive CWD detection is made in any cervid within the Jackson Elk Herd Unit
- Transport Restriction Zone
    - One or more contiguous counties, or portions of counties, that contains the initial response area. Transportation of cervid carcasses or parts, as defined below, from the initial response are will not be allowed outside of this zone.
- Surveillance zone
    - The surveillance zone will be defined as the Jackson Elk Herd Unit, consistent with the Wyoming Game and Fish Department Chronic Wasting Disease Management Plan
- Changes to hunting regulations in this area after detection
    - It is mandatory that all elk harvested on the refuge are sampled for CWD
    - Extend season
    - Take actions to increase the likelihood of hunter success
    - Wyoming Game and Fish Department has a CWD surveillance program and tests all appropriate samples received.
    - New requirements for hunting guides?
        i. Educate and post information for hunters regarding transmission of CWD
        ii. All animals acquired by the clients must be sampled for CWD
        iii. The hooves of horses used for hunts should be picked before being loaded on the trailer
- Changes to visitor access in this area after detection
    - Horses used on the refuge should have their hooves picked prior to being loaded on the trailer
- Review the current practice of collecting and selling antlers
    - 8,000 lbs of antlers sold every year
    - Boy scouts collecting
    - Considerations should be made for antler material entering medicinal or food chain

Biosecurity and Biosafety

- Biosecurity
    - Although decontamination is achieved by only a few chemicals, appropriate disinfection will reduce CWD transmission risk. Most disinfectants have only been demonstrated to be effective under controlled laboratory conditions.
    - Supplies and equipment must be first cleaned to remove large amounts of dirt and debris before they may be disinfected. After disinfection, rinsing with water may reduce the risk of damage to equipment.
        i. Concentrated (40% solution) household bleach may be effective in decontaminating instruments if immersed for up to 5 minutes.
        ii. CIP100 is an alkaline cleanser that is effective at prion disinfection by soaking for at least 15 minutes in a solution of 2 ½ ounces per gallon of 113 degree F water.

iii. Hypochlorous acid (HOCl, Briotech, Inc.) may be effective in decontaminating instruments susceptible to damage from caustic chemicals.

- In spite of the existence of disinfection protocols, equipment used in a CWD-affected area should not be transported to or used in an area not affected by CWD.
- Employees' boots may effectively transfer infectious CWD materials. Following removal of large dirt and debris, use of a boot bath or disinfectant mat with any of the disinfection agents above will reduce the risk of CWD contamination of other areas.
- Cervid carcass management could potentially have significant trophic effects on carnivores and scavengers, such that appropriate disposal of the most infectious CWD carcass materials should be used to reduce transmission risk while still allowing for scavenging of the remainder of the carcass.
    - Incinerate:
        1. Complete carcasses of all cervids showing clinical signs
        2. Remaining portions of all previously scavenged carcasses
        3. Head, spine and bones of all cervids
    - Allow to remain on the landscape for availability to scavengers:
        1. Muscle
        2. Organs, excluding brain and spinal cord (head, spine and bones will be incinerated)
- Transport of materials for incineration should be completed with dedicated vehicles that travel the minimum distance possible. Vehicles should be cleaned, and possibly disinfected, before entering areas not affected by CWD.

- Biosafety
    - To maximize safety, protocol reviews and Job Hazard Analysis should be completed prior to the following activities:
        i. CWD sampling (WGFD guidance on website, https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Wildlife-Disease/CWD-in-Wyoming-Wildlife/CWD-Testing)
        ii. euthanasia with firearms
        iii. carcass handling
        iv. incineration
    - For potential public health issues and their mitigation; see Centers for Disease Control and Prevention (https://www.cdc.gov/prions/cwd/index.html) and Wyoming Department of Health (https://health.wyo.gov/publichealth/infectious-disease-epidemiology-unit/disease/prion-diseases/).
    - Testing hunter-killed animals, reporting (currently available through WFGD)
    - Personal Protective Equipment (PPE) as defined by the JHA's mentioned above, should be maintained in adequate supply at all times. At a minimum, disinfectable boots, coveralls and disposable gloves should be worn at all times when working with materials potentially infectious from CWD. Eye protection may also be appropriate.

Begin heightened CWD surveillance

- During feeding season: Daily observation of animals during feeding for 60 minutes (increased from 30 minutes); euthanasia and removal of animals with clinical signs consistent with CWD
- Weekly observation of cervids (moose, deer, elk) for clinical signs consistent with CWD during weekly ungulate counts
- During periods of elk occupancy on refuge outside of the feeding season, increase frequency of observations to identify animals with clinical signs consistent with CWD
- Area of increased surveillance: the standard ungulate survey area: 11,400 acre (southern half of the NER)
- Explore use of drones for detecting animals with clinical signs
- CWD testing
    - Priority animals
        - all symptomatic animals
        - road kills – this is the jurisdiction of WGFD and the Wyoming Department of transportation, however refuge staff will respond to carcasses when needed.
        - wolf kills – consider collaring additional wolves to facilitate early detection of wolf kills for CWD detection.
    - Mandatory testing
        i. Increase surveillance and sample numbers to heighten detection levels to 99% confidence interval
        ii. Institute mandatory testing of elk harvested on NER for CWD
    - Wyoming Game and Fish Department retropharyngeal lymph node removal for CWD testing: https://wgfd.wyo.gov/WGFD/media/content/PDF/Vet%20Services/Removal-of-Retropharyngeal-Lymph-Nodes-for-CWD-Testing-WGFD.pdf

Information management and data sharing

Informal data sharing practices are already in place between WGFD, FWS, NPS

Communication with partners and stakeholders

- Coordinate with the R6 Regional Office and the NRPC Wildlife Health office
- Coordinate with the CWD Working Group and other Federal, State, and local agencies, tribal entities, producer groups, and the Land-Grant University-based Cooperative Extension System to ensure consistent messaging regarding wildlife health, livestock health, public health, and food safety
- Assure stakeholders that the Refuge is working on the issue in an informed and timely manner in close coordination with the Wyoming Game and Fish Department and the National Park Service.
- Talking points for WGFD, FWS, and NPS to use for consistency in messaging
- Distribute the pre-approved fact sheets
- Begin joint press releases
- Post Refuge website information and alerts
- Post Facebook, Twitter, Instagram and other social media updates

- Hold town hall meetings
- Response protocols for reporting of sick cervids by the public

Public outreach and education

- Follow pre-approved public information plan for CWD confirmation on NER, including a Frequently Asked Question sheet
- Brief the media, public, industry, and others on the CWD outbreak status and the actions being taken to control it
- Give consistent guidance (WGF, Bridger-Teton NF, Grand Teton NP and NER) of how the public can report sick cervids
- Increase outreach to Bridger-Teton NF, Grand Teton NP, and NER elk hunters in collaboration with WGFD
- Be clear about public health issues associated with CWD – work with local public health department and CDC

Feeding

- Preferred option with regards to feeding:
    - Reducing our reliance on supplemental feeding to decrease artificial congregations of animals that enhance CWD transmission.
    - Request to revisit the existing Bison and Elk Management Plan to change to state's elk population objectives

Euthanasia

- Continue use of non-toxic ammunition
- Welfare
    - Lethal collection of symptomatic animals for surveillance
    - Euthanasia protocol (Please see the end of this document or consult the euthanasia guidelines at https://sites.google.com/a/fws.gov/fws-wildlife-health/animal-welfare)
        - Euthanize if any of the following signs are present:

            1. Weight loss
            2. Decreased social interaction, loss of awareness
            3. Tooth grinding
            4. Altered posture (head and ears lowered, wide-based stance)
            5. Head tremors
            6. Incoordination
            7. Increased drinking
            8. Excessive salivation

        - Consider timing, location, and people present when preparing to euthanize
    - Ensure CWD sample collection is performed on each euthanized animal

Disposal

- Shared regional incinerator meeting temperature specifications for prions
- Established protocols for the incinerator
    - Where will the ashes go, how will they be packaged and transported
    - Air quality issues
    - Generator, fuel
    - Dedicated equipment for lifting animals into the incinerator
    - Incinerator "membership" – i.e. what agencies will have use of it – recommend not allowing use by entities outside the Jackson Elk Herd Unit (or county?) to reduce risk of anthropogenic introduction from outside.
- Back-up option for when the incinerator goes down (municipal landfill? Walk-in freezer? Portable incinerator)
- Set maximum travel distances with potentially positive carcasses (i.e. out of the county? Jackson Elk Herd Unit?)

Habitat

- Consider cost/benefit of habitat and forage enhancement on the refuge relative to artificially concentrating animals and creating potentially highly contaminated areas on the refuge.

Cleaning and Disinfection

See section 15 (Recommended Decontamination and Disinfection Methods for Equipment, page 76) of the AFWA Technical Report on Best Management Practices for Prevention, Surveillance, and Management of Chronic Wasting Disease: https://www.fishwildlife.org/application/files/9615/3729/1513/AFWA_Technical_Report_on_CWD_BMPs_FINAL.pdf

Health and Safety and Personal Protective equipment

See section 22 (CWD and Public Health, page 106) of the AFWA Technical Report on Best Management Practices for Prevention, Surveillance, and Management of Chronic Wasting Disease: https://www.fishwildlife.org/application/files/9615/3729/1513/AFWA_Technical_Report_on_CWD_BMPs_FINAL.pdf

Research opportunities

- How will conducting research, collecting additional samples influence the response?
- Update existing CWD population models with additional prevalence and demographic data
- Predation of CWD positive animals by predators

    - Test the hypothesis that predators preferentially select CWD positive prey
    - Digestion/pass-through and prion load in predators
- Ante-mortem testing techniques
- Environmental sampling to estimate prion loads
- PRNP polymorphism, genotyping, and CWD latency
- Use of drones for monitoring
- Quantifying elk density and aggregation patterns relative to infectious disease prevalence and transmission on the refuge
- Remote sensing of native range productivity and availability of forage to inform feed season start and end dates

Field euthanasia of ungulates

According to the American Veterinary Medical Association Euthanasia Guidelines (the animal welfare gold standard for euthanasia techniques in vertebrates), the only *acceptable* methods for euthanasia of wild ungulates are the noninhaled agents, specifically barbiturates and barbituric acid derivatives (such as pentobarbital).

Current federal drug regulations require strict accounting for barbiturates, and these must be used under the supervision of personnel registered with the US Drug Enforcement Agency (DEA).

Given that these drugs are not always available for use by biologists without the presence of a veterinarian, and that chemical euthanasia may create secondary toxicity in scavengers and humans, the methods of euthanasia listed in this fact sheet are *alternatives* to euthanasia by lethal injection and are all considered *acceptable with conditions*. This categorization means that: certain conditions must be met to consistently produce humane death; the euthanasia methods may have greater potential for operator error or human safety hazard, are not well documented in the scientific literature, or may require a secondary method to ensure death. A*cceptable with conditions* for physical methods of euthanasia also suggests that sedation or anesthesia be used in conjunction with these methods as a best practice.

Irrespective of the approach you choose, all methods of euthanasia should be performed in a low stress, quiet environment and only by properly trained personnel. Contact the Wildlife Health office for more detailed information and training opportunities on humane euthanasia techniques for free-ranging wildlife.

Which method of euthanasia is right for your situation?
The chart on the next page lists the euthanasia techniques that are *acceptable with conditions* and can be applied by a biologist in the field. The method you chose will depend on a number of factors:

a) the ability of personnel to induce loss of consciousness and death using a given technique without causing pain or distress
b) reliability and safety of the technique
c) training and logistics required for use of the technique in the field or facility
d) the health status of the animal and how easily it can be captured
e) compatibility with the purpose for euthanasia (such as needing to preserve brain and lymph node tissue for diagnosis of Chronic Wasting Disease, CWD)

Unacceptable methods of euthanasia for all species: freezing, drowning, use of car exhaust or other unapproved gases, injection of chemicals other than anesthetics or euthanasia solution(s).

Please do not hesitate to contact us with questions: Sam Gibbs: 571-216-5776, Samantha_Gibbs@fws.gov
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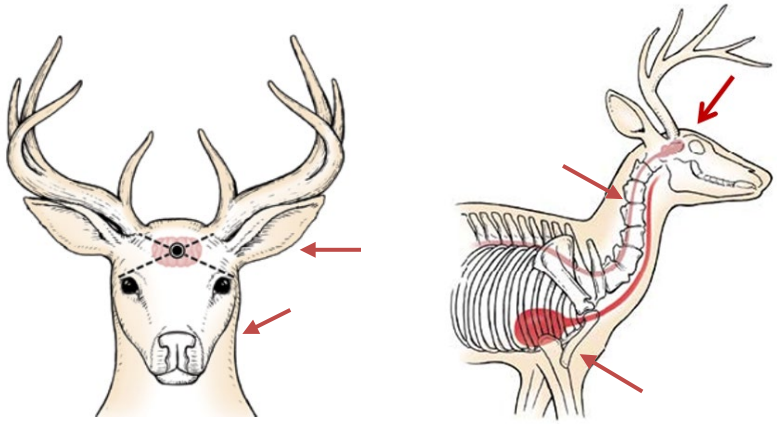
Field euthanasia of ungulates

Categorized as acceptable with conditions for ungulates

	Gunshot or Captive bolt
Mode of action	Head shot - physical damage to brain; direct concussion of brain tissue. Cervical spinal cord – respiration and cardiac function cease. Heart shot – blood loss. **A neck shot may be preferable to a head shot in order to preserve the lymph nodes and brainstem for CWD testing**
Training required	Yes
Animal welfare considerations	If the animal is injured but not killed, it should be dispatched by a second shot or exsanguination
Restraint necessary	No – may be applied to free-roaming animals; may also be performed at point-blank with animal inside cage trap
Rapidity	Immediate, muscle activity may continue
Safety for personnel	Injury to personnel, the public, and other animals
Biosafety/ biosecurity concerns	Exposure to brain tissue and blood
Carcass consumption by scavengers	Depends on type of shot used; animals euthanized with lead shot should be made unavailable to scavengers
Impacts on sample collection	Cannot use brain for diagnostics if a head shot is used
Portable into the field	Yes
Equipment needed	Firearm, ammunition; captive bolt, charge
Cost	$800 – 2,000



Under field conditions, gunshot can be targeted at the brain from in front of the animal (at close range) or the side; at the vertebral column (neck shot is acceptable if it severs the vertebral column and spinal cord); or the heart. A second shot may be required to ensure quick death.

Firearms and shot placement:

- Using firearms greater than .22 caliber is essential to penetrate the skull of adult animals, solid-point bullets are preferable
- Rifles are more appropriate for euthanasia of ungulates than shotguns, as some types of slugs have high expansion with poor penetration
- Have two firearms on-site and ready with appropriate ammunition for euthanasia operations to ensure a second shot can be placed quickly when necessary
- If no diagnostic tests are planned, and no specimen preservation is needed for health or forensics, a shot to the brain is the preferred method
- If a necropsy is planned, or chronic wasting disease testing desired, a neck shot should be implemented
- A heart shot is the least preferred method as time to death is longer

Death of shot animals should always be confirmed by observing the following:

- Absence of rhythmic, respiratory movements
- Absence of heart beat
- Absence of eye protection reflex (corneal reflex) or 'blink' when surface of eye is touched
- A fixed, glazed expression in the eyes
- Loss of color in mucous membranes (become mottled and pale without refill after pressure is applied)

References

- American Association of Zoo Veterinarians (AAZV). Guidelines for Euthanasia of Nondomestic Animals. 2006
- AVMA euthanasia guidelines 2013: https://www.avma.org/KB/Policies/Documents/euthanasia.pdf
- Longair JA, Finley GG, Laniel MA, et al. Guidelines for the euthanasia of domestic animals by firearms. Can Vet J 1991;32:724–726. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1481111/pdf/canvetj00073-0022.pdf