Review of Cervid Carcass Disposal Methods in the Context of Chronic Wasting Disease Management

Wildlife Health Committee

May 2025

Executive Summary

Cervid carcasses infected with chronic wasting disease (CWD) prions can contribute to environmental contamination, serving as potential sources of infection for uninfected cervids.[1] The movement of such carcasses can facilitate the introduction and geographic spread of this disease to new areas within and across jurisdictions.[2] Many stakeholders play a role in cervid carcass handling and disposal, including in-state and out-of-state hunters and outdoor recreationists, game processors and slaughter plant owners, taxidermists, department of transportation staff, landfill operators, and captive cervid owners. For these reasons, wildlife agencies must understand the various options and best management practices for carcass and carcass waste disposal in order to provide sound guidance for cervid carcass disposal. In some cases, wildlife agencies may need to work with other agencies in their jurisdiction to enact practices or regulations to ensure appropriate disposal of cervid carcasses. In this document, we review cervid carcass disposal options including advantages, disadvantages, and considerations for each based on current knowledge, wildlife agency experiences, and relevant literature.

Best management practices for disposal of cervid carcasses and carcass waste remain a topic of concern among state, provincial, and territorial wildlife agencies (hereafter "agencies") managing chronic wasting disease (CWD). Anderson (2023) found that of the 46 U.S. states that have a CWD management plan, 76% address disposal of cervid carcasses (Fig. 1).[3] Four Canadian provinces also have a CWD plan that addresses carcass disposal (Fig. 1). Although much information on CWD exists in the literature, relatively little specifically addresses CWD-relevant carcass disposal issues. Furthermore, not all options are feasible, affordable, or publicly acceptable in all circumstances and jurisdictions. For example, a 2022 survey of U.S. state wildlife agencies found that most agencies rely on landfills to dispose of cervid carcass waste.[3] However, this option may not remain sustainable in all areas as some surveyed agencies reported that landfill operators stopped accepting carcass waste when the volume became excessive. Anderson (2023) also noted that it is likely that landfill owners will stop accepting cervid carcasses immediately if zoonotic transmission of CWD occurs. Even in the absence of supporting evidence for zoonotic potential of CWD, public and media interest alone can drive the willingness of landfill managers to accept cervid carcass waste. Therefore, agencies must be familiar with and prepared to recommend and use a variety of carcass disposal options to reduce the risk of CWD introduction and transmission.

Here we discuss the five identified AFWA best management practices (BMPs) for carcass disposal, as well as three others (leave-in-field, burial, and rendering) including advantages, disadvantages, and unique considerations for each. The presented material can apply to whole carcasses (e.g., ones that test positive for CWD) and carcass waste. Further, we provide draft language for agencies to consider in instances where regulations may need to be implemented or updated to facilitate proper disposal of cervid carcasses to reduce the risk of this potential means of CWD introduction and spread.

1. **Leave-in-field**

   This first disposal option focuses on encouraging hunters to leave their harvested cervid carcass waste at the site of harvest.

   Advantages: This method requires agencies to expend the fewest resources (money or staff time), may be the most convenient for the hunter, and reduces biosecurity risk associated with moving infected carcasses to new locations.

   Disadvantages: Leaving infected carcass remains in the field may facilitate environmental transmission of CWD,[1,2,5,6] potentially maintaining or increasing the prevalence of CWD in an area. One study found that intact carcasses may persist in the environment up to 101 days depending on climate[6] and prions may remain infectious in the environment for 2+ years.[1,7] Carcasses can also be consumed by scavengers, which has a potential risk for prion movement to other areas.[6,8] This option may also facilitate illegal activity because it is hard to determine whether hunters are leaving or returning carcass parts legally or dumping them illegally.

   Considerations: If hunters choose to take their harvest to a meat processor or taxidermist or process the carcass at home, this option may not be an effective option because hunters are unlikely to bring unused carcass parts back if taken from the site of harvest. Thus, these carcasses will be disposed of using a different method or deposited in an area away from where it was harvested. For these situations and for processors and taxidermists in general, agencies should provide additional guidance for cervid carcass disposal. This option can confuse the public. Agency messaging that demonstrates carcass waste as a potential source of transmission but also promotes leaving such material on the landscape can seem counterintuitive. Agencies must craft outreach materials to address this common misunderstanding. Staff may also need guidance and regular reminders for proper carcass disposal (e.g., staff cannot dispose of cervid carcasses in the nearest agency-owned management area regardless of convenience).

   Regulation language from two states: "*A hunter may dispose of a carcass or offal of cervid species on the property where the animal was taken, but the carcass or parts shall*

be deposited at least 300 feet from a building, maintained road, parking area, public access facility or gate, or established hunting blind, unless otherwise prohibited and as long as the big game is not removed from the property and then returned thereto."

"Deer, elk and moose taken in [state] may be transported within [state] to a camp, a private residence for processing, a taxidermist, a processor, or a CWD sample collection site in [state], provided the head and all portions of the spinal column remain at the site of the kill or such parts are disposed of in any approved landfill or approved incinerator in [state]."

2. **Burial**

Agencies may recommend burying carcasses on- or off-site and with or without regulations specifying lawful burial practices. Regulations often include a specified burial depth and distance away from water.

Advantages: Hunters may find burial more acceptable than leave-in-field disposal or other options. Burial may reduce the risk of 1) scavengers spreading cervid remains on the landscape, and 2) contact between live cervids and carcass parts.

Disadvantages: This method requires more hunter and staff time and effort to bury carcasses compared to the leave-in-field method. There is also a risk for water quality issues and environmental prion persistence.[9] Prions can be taken up by plants and carcasses can be scavenged and contaminate groundwater if not buried properly.[10,11] Carcass burial may not be permitted by local ordinances,[11] and it is not feasible in northern regions when the ground is frozen. Burial is difficult in areas with low water tables.[11]

Considerations: Most states have environmental quality regulations for burying carcasses. To prevent water contamination, the U.S. Environmental Protection Agency (EPA) recommends that burial sites not be located in areas with a high water table or in very permeable soil, and carcasses should be buried at least 300 feet from standing, flowing, or ground water (e.g., drinking water well, creek, pond) and not in a floodplain.[12] Carcasses should be buried at least 200 feet from property lines. Pits should be at least 4 feet in depth with at least 2 feet of soil covering the carcass. Carcasses should be placed side by side or end to end and not stacked.[12] Clay liners are recommended for pits because of the ability of clay to bind to prions.[13]

Example regulation language: "*Burying the carcass and all of its parts and products in the earth at a point which is never covered with the overflow of ponds or streams and which is not less than one hundred (100) feet distant from any watercourse, sinkhole,*

well, spring, public highway, residence, or stable. The carcass shall be placed in an opening in the earth at least four (4) feet deep, the abdominal and thoracic cavities opened wide their entire length with a sharp instrument, and the entire carcass covered with two (2) inches of quicklime and at least three (3) feet of earth."

3. **Landfill**

Disposal of carcasses in landfills is the most common method used by agencies (84% of state agencies according to Anderson, 2023). The EPA recommends that only landfills that satisfy requirements for siting to flooding and aquifers, engineered containment, and leachate and gas management with prerequisite permit conditions should be considered for carcasses.[12] These landfills are typically licensed subtitle D landfills as established in the Resource Conservation and Recovery Act, which sets federal standards for landfill operations (USA), or approved Class C landfills (CAN) with clay liners, geomembranes, and leachate- and gas-collection systems.[14]

Advantages: Landfills are a "conventional resource with existing infrastructure," have "relatively broad geographic accessibility,"[3,12] and "properly licensed and operated landfills offer one of the most economically feasible options for disposal of carcasses and parts, particularly in high volumes".[4] There is low probability that landfilled carcasses contribute to additional environmental transmission because carcass prions are contained and typically inaccessible to cervids and scavengers.[13]

Disadvantages: Landfills may discontinue accepting carcasses when volume becomes excessive.[4] As a result, options for alternative disposal practices and guidelines must sometimes be adopted, often with short notice. Even without the issue of large volumes, many landfills no longer accept cervid carcasses due to concerns about public perception, employee safety, and leachate risks or other concerns associated with prions.[16,17] If regulations provide for landfill disposal via waste management provider, buy-in must be maintained among additional entities such as waste haulers and municipalities overseeing landfills. Landfills may not be broadly accessible or economically feasible in some areas. For example, some landfills in Washington require a $200+ fee per carcass. Lastly, transporting carcasses to landfills may be costly.

Considerations: The EPA suggests municipal solid waste landfills should be 40 CFR Part 258 compliant and have no uncontrolled release from the disposal cell.[18] If landfills collect leachate, EPA recommends re-circulating it within the landfill and not discharging to a publicly owned treatment works (i.e., government-operated sewage treatment system) or through a direct discharge National Pollutant Discharge Elimination System (NPDES) permit.[18] EPA provides further recommendations for

leachate handling.[18] Cooperative agreements between the wildlife agency and the agency regulating landfills can facilitate proper carcass disposal.[19] It is recommended that records of contracts or permission from each participating landfill be maintained,[18] and a list of approved landfills that accept carcasses be developed, made available to hunters, and kept up-to-date.[19] If feasible, it is recommended that agencies regulate carcass disposal in landfills, such as requiring carcass parts to be double-bagged. Agencies should consider the local characteristics of each landfill (e.g., depth to groundwater, soil type)[19] when deciding which landfills to recommend to hunters and other stakeholders for carcass disposal. It is recommended that agencies request landfill operators segregate CWD carcasses from other waste disposal areas and identify and maintain records of the boundaries of the carcass area.[18] If uncertainty or perceived risks of CWD prevent landfill operators from accepting carcasses, conversations with public health officials may alleviate concerns.[3] Lastly, agencies may consider developing and managing their own landfill(s) if other landfills stop accepting carcasses.

Example regulation language: "*Carcasses shall be disposed by … depositing the carcass in a contained landfill, as established by [your jurisdiction's regulation defining landfills].*"

4. **Incineration**

Incineration of carcasses can inactivate prions and reduce CWD risk when done in an EPA-approved conventional incinerator, air curtain incinerator, or cement kiln. Temperatures must approach 1000°C (1832°F) to deactivate prions.[4,20,21] Incineration is the second most popular disposal method according to Anderson (2023), with 20 agencies indicating that they incinerate cervid carcasses, although it is unknown how many or what type of carcasses (e.g., hunter-harvested, agency-culled, suspect clinical) are incinerated by these agencies.

Advantages: Carcasses do not contribute to environmental transmission when incinerated at appropriate temperatures and incineration can be highly biosecure.[12]

Disadvantages: Prions can withstand temperatures of 600°C. Incinerators must operate at a minimum of 900°C for prion deactivation.[14,21] For some tribal groups, carcass incineration is not a culturally acceptable practice.[4] Incinerators are expensive,[22] require routine maintenance, can be difficult to operate and manage,[12] and are subject to air quality regulations.[11] Incineration contributes to greenhouse gases and requires high energy input. Often, established incinerators are not located near areas with CWD.

Considerations: Incinerator operation requires a permit from the environmental quality agency in most U.S. states and some Canadian provinces. Privately-owned pet cremation incinerators may not reach temperatures high enough to deactivate

prions.[11] Agency-owned and operated incinerators may be an option, but staff time for general maintenance needs to be allocated accordingly. Resulting ashes should be buried in an approved landfill. Agencies must anticipate annual fuel and maintenance costs, which often makes incineration not cost-effective. Incinerating large volumes of carcasses may lead to back-up as only a few carcasses can be incinerated at once. Carcasses must be stored in biosecure locations while waiting to be incinerated. Extra staff time is required to transport carcasses to the incinerator location(s). Most taxidermists, processors, and captive cervid owners do not have access to incinerators.[3] There are public perception problems with carcass incineration (e.g., Larimer County, CO local anti-incinerator sentiments).[12]

Example regulation language: "*All carcasses shall be disposed of by… complete incineration of the entire carcass and all of its parts and products... and all products of incineration must be disposed of in an approved landfill*"

5. **Composting**

Composting is a natural process of aerobic decomposition, stabilization of organic matter, and thermophilic temperature development, and is used to successfully destroy livestock carcasses. Successful composting of carcasses requires monitoring of temperatures and a mix of organic materials. In 2022, three U.S. agencies included composting as a disposal method they use for cervid carcasses, although it is unknown how many or what type of carcasses (e.g., hunter-harvested, agency-culled, suspect clinical) are composted by these agencies.[3] As with landfills and burial, stakeholders and agencies may need to transport carcasses to an agency-operated composting site or establish their own compost pile.

Advantages: Composting can significantly reduce prion infectivity.[23] It is cost-effective and environmentally and socially acceptable.[11] Composting can be done when the ground is frozen.

Disadvantages: Composting does not reliably inactivate all prions.[24] Carcasses may take many months to decompose, particularly in cold climates. Composting requires initial start-up costs, labor, and some maintenance, such as turning of the compost material and adding supplemental moisture. This method requires machinery and a specific mix of ingredients or materials (e.g., carbon sources, bulking agents, and biofilter layers).[12] Compost site nutrient mix, moisture, temperature, and pH must be carefully manipulated and controlled. It remains unclear how scalable composting is to handle large volumes of hunter-harvest carcasses and if this method requires too much technical expertise from agency staff or stakeholders (e.g., hunters, processors).

Considerations: Composting is only effective when the right mixture of carbon, nitrogen, and moisture is provided, and the process must be tailored to individual climates. For example, in Wyoming, USA, carcass decomposition requires additional water due to the arid nature of the region.[25] Additives such as proteolytic microorganisms can enhance the composting process.[23] Run-off must be controlled and composted material must not be spread on the landscape.[4] Traditionally, the output product from composting operations results in a fertile soil product; however, until further research is done on appropriate prion degradation as a result of composting, any byproduct or resulting soil product should not be used to fertilize crops meant for animal or human consumption. Some state departments of agriculture sell compost from commercial meat processors to farmers. Agencies should work with their departments of agriculture to ensure that commercial meat processors who also process wild game do not sell their compost to farmers.

6. **High-pressure alkaline hydrolysis**

In high-pressure alkaline hydrolysis, carcasses are exposed to highly concentrated NaOH or KOH in a pressurized tissue-digestor vessel and heated to 150°C for a minimum of three hours.[26] Treated material must be buried or sent to an approved landfill. In 2022, eight agencies disposed of carcasses using this method.[3] In 2004, one company, Waste Reduction, Inc., reported that it had 30-40 digestion units in operation in the U.S., with many used to dispose of CWD-infected deer carcasses.[12,27] Updated information about Waste Reduction Inc. cannot be located. However, numerous companies advertise the acceptance of carcass waste for alkaline digestion online. For example, BioSAFE Engineering (Indianapolis, IN) advertises that their tissue digesters can inactivate prions and operate between $0.03-0.06 per pound compared to incinerators operating at $0.75+ per pound.[28]

Advantages: Alkaline hydrolysis effectively inactivates prions[15,20] and has fewer environmental impacts than incineration,[11] with no emissions and minor odor production.[12]

Disadvantages: Start-up and maintenance costs may be cost-prohibitive. A Colorado Parks and Wildlife (CPW) representative guessed that each digester purchased by CPW was likely in the “several hundred-thousand-dollar range.”[3] They reported an estimated $0.50 per pound disposal cost and noted that it was an unreliable method because “the digester is rarely operational.”[3] This method is typically only appropriate for a small number of carcasses.[11]

Considerations: State and federal permits may be required. Treated material must be buried or sent to an approved landfill. Six-hour treatment is recommended for prion-

contaminated materials, as one study did not find three hours long enough to effectively eliminate prion infectivity.[29]

7. **Centralized carcass disposal sites**

This method is an intermediate step towards one or more of the other disposal methods. Agencies establish centralized disposal sites, often by providing dumpsters in or near CWD-affected areas. The Anderson (2023) survey found that nine agencies provided dumpsters or other temporary sites for carcass and carcass waste collection.

Advantages: Providing this service may increase regulatory compliance. Agencies have reported that hunters tend to support this method. Non-government organizations are often interested in sponsoring such programs (see example below). This method can have the added advantage of facilitating buy-in with CWD management from stakeholders. Agencies maintain more control of carcass disposal.

Disadvantages: Agency directed dumpster programs can be expensive and time consuming to maintain. Hunters may become dependent on dumpsters for carcass disposal; however, it is unclear whether agency-led programs are sustainable over time.[3] Transporting potentially infected carcasses to centralized sites poses a biosecurity risk.[11] Transporting dumpsters to landfills also poses a theoretical biosecurity risk.[11] Poorly maintained, overflowing carcass dumpsters provide bad optics. Vendors to supply dumpsters may not be readily available in all locations.

Considerations: Centralized sites must be conveniently located for hunters to be willing to use them. Agencies may use dumpster liners to enhance biosecurity; however, some agencies have had issues with them. Dumpsters without liners should be considered contaminated, locked during the off-season, and kept on site year-round. Dumpsters must have working, secure lids, especially where bears occur.[3] Oversight is often needed to prevent non-carcass waste disposal by the public.[3] Jurisdictional (e.g., state or provincial) rules and requirements around procurement of vendors may limit an agency's ability to reduce costs.[3] Some agencies partner with nongovernment organizations to initiate "adopt-a-dumpster" programs. For example, a grassroots program was initiated in Wisconsin, where nonprofits and other nongovernment entities funded dumpsters. Conversely, Minnesota Dept. of Natural Resources (MN DNR) adopted a state-sponsored "adopt-a-dumpster" program; MN DNR noted that they would not be able to go backward to a grassroots approach (i.e., nongovernment entities would not be willing to begin paying for dumpsters) if state funding was no longer provided.[3,16] MN DNR also provided quartering stations at their dumpster sites as an added non-controversial incentive for hunters to use the sites.[3] MN DNR paid $170,000 in 2019 to place 26 dumpsters in two CWD control zones. In

2022, MN DNR paid $234,000 for 42 dumpsters in five CWD zones.[3] When dumpsters were provided by Pennsylvania Game Commission, regional branches felt burdened by the logistics involved, such as establishing contacts and ensuring that waste was dumped when dumpsters were full.[3]

8. **Rendering**

Rendering is a commercial cooking and drying procedure involving physical and chemical processes to produce usable end products (carcass meal, melted fat or tallow, water) from carcasses and offal.[11] It is a common method for livestock carcass disposal; however, there is a lack of information on the use of rendering by wildlife agencies managing CWD in free-ranging cervid populations.

Advantages: Readily available in some jurisdictions. Resulting products are useful (e.g., used in the agricultural animal and soil industries).

Disadvantages: Rendering is unlikely to eliminate prion infectivity,[26] so the byproducts should not be used in instances where animal or human food contamination can occur. There may be few or no rendering facilities within a jurisdiction. Transport time to rendering facilities may exceed the time window for carcass acceptance by facilities.[11] Federal restrictions limit the type of tissues that can be rendered, which has caused a decline in the number of rendering facilities in the U.S.[11] Rendered materials are often returned to the environment, thus potentially spreading CWD.

Considerations: Resulting carcass meal and tallow are often added to animal feed. Bovine spongiform encephalopathy (BSE or "mad cow disease") emerged after the products of rendered prion-infected sheep and/or cattle carcasses were fed to cattle. Some rendering plants may be designated for producing end products contaminated with prions, where products will be used only for amending agricultural soils and/or as burning fuels.[12] **This method is not considered acceptable for cervid carcass disposal if potentially prion-containing end products will be fed to other animals or spread on the landscape.**

Example regulation language: "*Carcasses shall [or shall not] be disposed of… by removal of the carcass by a duly-licensed rendering establishment*." Or "*…by licensed rendering establishment.*"

Additional broad considerations:

- This document focuses on disposal of free-ranging cervid carcasses. If an agency regulates the disposal of captive cervid carcasses, it should be noted that others have

reported difficulty associated with oversight of disposal practices used by captive cervid facilities, even when routine standard inspections are performed.[3]
- It is recommended that agencies work with their jurisdiction's transportation department to understand how road-killed cervids are handled and provide recommendations.
- The EPA compared costs across disposal methods and a summary table is presented below (Table 1).[12] More cost information can be found in the original EPA document.[12]
- There is a research deficit regarding appropriate carcass disposal and impact of the methods highlighted in this document.
- State or provincial environmental quality departments (e.g., DEQ) may be a good resource when considering carcass disposal practices.

Conclusions

There is no one best practice for cervid carcass disposal. However, general best management practices have been established using the disposal methods highlighted in this document.[4] Wildlife agencies must weigh all advantages and disadvantages for each to decide which method(s) will be the most feasible and effective in their jurisdiction. Given the lack of research and knowledge surrounding the impacts of individual disposal methods on reducing environmental prion contamination, agencies may consider implementing new disposal methods in a way that allows for the quantification of their effects on risk reduction of environmental contamination and indirect transmission of CWD. For example, if a carcass dumpster program is initiated, a cost-benefit analysis may be conducted if the agency records all costs and staff time associated with the program and how many carcasses are disposed of in the dumpsters to estimate percentage of use. Further estimation of the number of harvested cervids in the surrounding area(s) and/or a survey of hunters who hunt in the areas in which dumpsters are provided can determine the popularity of the dumpster program.

Some wildlife agencies managing CWD in free-ranging cervid populations have concluded that using more than one disposal method is more beneficial than limiting options and recommendations to just one method. A key to success is to work with other stakeholders beyond cervid hunters, such as processors, taxidermists, captive cervid owners, Department of Transportation staff, EPA and DEQ staff, and landfill operators to ensure all parties are following best management practices when handling carcasses.

Figure 1. Survey responses from U.S. states obtained by Anderson (2023)[3] and emailed responses from Canadian provinces and territories to N. Thompson (April 2025) regarding whether cervid carcass disposal is addressed in their wildlife agency's CWD plan and/or response.

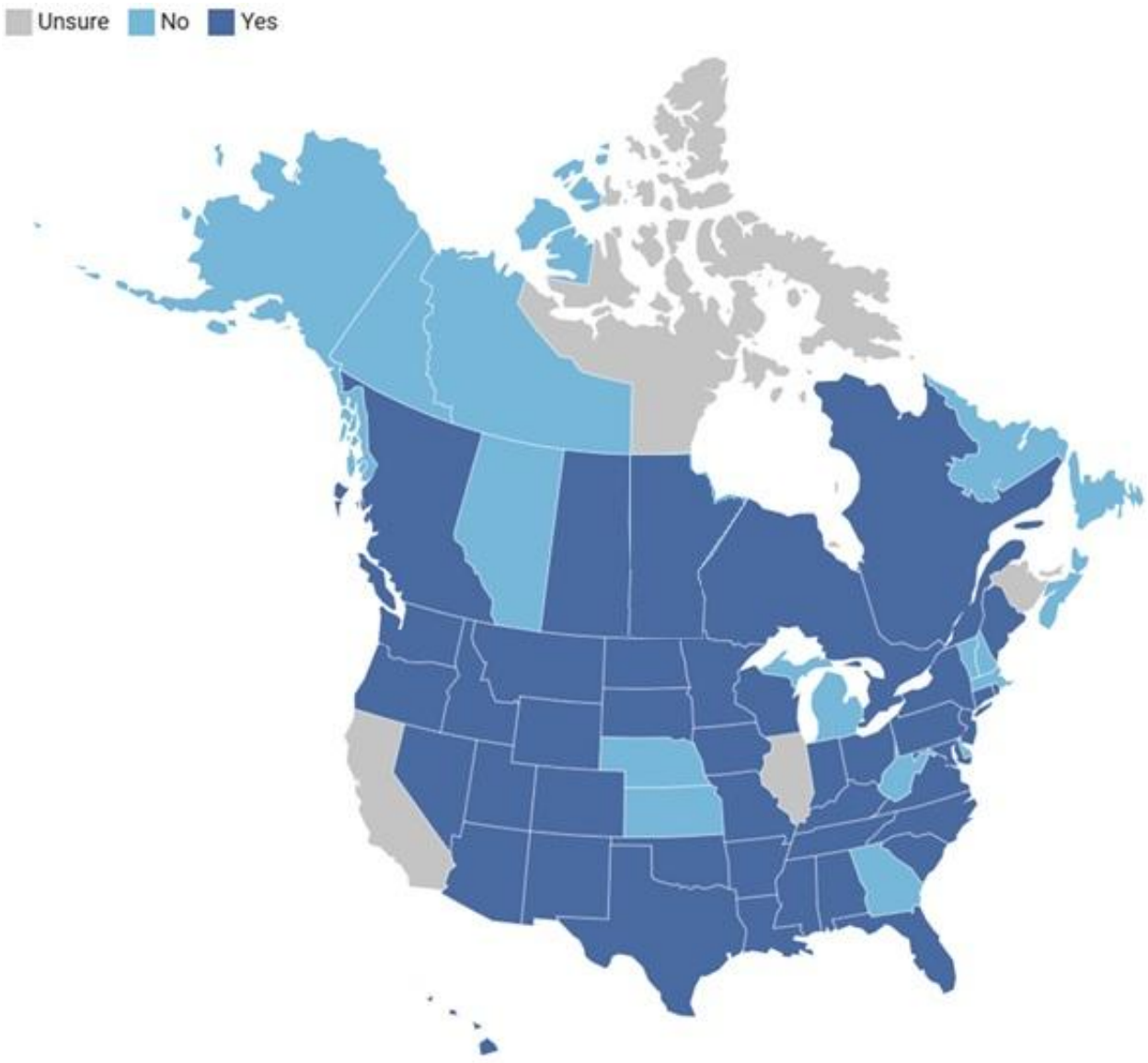

Table 1. Summary of carcass disposal costs estimated by the U.S. Environmental Protection Agency taken directly from their Waste & Debris Fact Sheet.[12]

Technology	Range of cost estimates per ton of carcass material disposed[a]	Direct Cost Indicators				Indirect Cost Indicators			Creates valuable or beneficial byproducts
		Initial capital[b]	Transportation[c]	Labor	Inputs	Environment/ Public health	Public perception	Other cost considerations	
Burial (on- and off- site)	$15-200	$	$	$$$	$	$$$	$$$$	Land use and values. Predator activity	
Landfill usage	$10-500	$$	$$$	$	$	$$	$$$	Municipal costs Management costs	
Open burning	$200-725	$	$	$$$	$$$$	$$$	$$$$	Disposal of ash Permit fees	
Fixed-facility incineration	$35-2000	$$	$$$	$$	$$	$$	$$$	Disposal of ash Permit fees	
Air-curtain incineration	$140-510	$$	$$	$$	$$$	$$	$$$	Disposal of ash Permit fees	
Bin & in-vessel composting	$6-230	$$	$	$$$	$$$	$	$$	Land use. Time efficiency.	X
Windrow composting	$10-105	$	$	$	$$$	$	$$	Land use. Time efficiency. Predator activity	X
Rendering	$40-460	$$	$$$	$$$	$$	$	$$	Biosecurity risk	X
Fermentation	$65-650	$$$$	$	$	$$	$	$	Time efficiency	X
Anaerobic digestion	$25-125	$$$$	$	$	$$	$	$	Time efficiency	X
Alkaline hydrolysis	$40-320	$$$	$$	$$	$$	$	$	Disposal of effluent	

[a] These estimates are the result of an extensive literature review which utilized numerous sources. The data available is based on a variety of assumptions, including differing circumstances, cause of death, scale of disposal efforts, species, dates, and geographical locations. In addition, different cost estimates do not consistently incorporate capital, transportation, labor or input costs.

[b] Includes capital costs directly associated with carcass disposal only.

[c] Transportation costs depend on the location of the technology. These indicators assume minimal transportation for more likely available technologies.

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