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Assessment of United States Department of Agriculture Food Safety Inspection Service Humane Handling Enforcement Actions: 2018–2020

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ABSTRACT

Federally inspected slaughter establishments in the United States must adhere to the Humane Methods of Slaughter Act and regulations that enforce it. Failure to comply with this law results in a Humane Handling Enforcement Action (HHEA) issued by the United States Department of Agriculture Food Safety Inspection Service (USDA FSIS). The objective of this study was to systematically analyze and describe HHEAs issued between 2018 and 2020. Enforcement action notification letters were accessed from the USDA FSIS website and date, location, regulatory action, reason for noncompliance, species, and follow up action for each HHEA was recorded. Summary statistics (proportions and percentages) were calculated for the entire population dataset. Between 2018 and 2020, FSIS issued 293 HHEAs; 109 in 2018, 85 in 2019, and 99 in 2020. The majority of HHEAs (64.16%; 188 of 293) were related to the mechanical stunning of bovine (39.93%; 117 of 293) and porcine (24.23%; 71 of 293) species. The majority (50.23%; 107 of 213) of causative reasons for mechanical stun failure across all species were not clearly described; however, of those that were, most (39.12%; 68 of 213) were related to the placement of mechanical stuns. Addressing these issues through improved training and research would help to reduce the total number of HHEAs. Additional detail in reporting the events that result in HHEAs from USDA FSIS would aid in guiding corrective actions on an industry-wide scale.

Key words: handling, humane, inspection, slaughter, stunning, welfare

Abbreviations: AVMA, American Veterinary Medical Association; HHEA, Humane Handling Enforcement Action; IIC, Inspector in Charge; IPP, Inspection Program Personnel; NAMI, North American Meat Institute; NOIE, Notice of Intended Enforcement; NOS, Notice of Suspension; PHV, Public Health Veterinarian; ROS, Reinstatement of Suspension; USDA FSIS, United States Department of Agriculture Food Safety Inspection Service

INTRODUCTION

In the United States, federally inspected slaughter establishments must comply with the Humane Methods of Slaughter Act (7 USC 1901) (United States House of Representatives Office of the Law Revision Council, 2022) and the regulations that enforce it (9 CFR 313) (United States Electronic Code of Federal Regulations, 2022a). The Humane Methods of Slaughter Act (7 USC 1901) states that “the slaughtering of livestock and the handling of livestock in connection with slaughter shall be carried out only by humane methods” (United States House of Representatives Office of the Law Revision Council, 2022). Humane handling is defined by the United States Department of Agriculture (USDA) Food Safety Inspection Service (FSIS) as “handling and slaughter practices that cause a minimum of excitement, pain, injury, or discomfort to livestock” (USDA FSIS, 2020). Egregious inhumane treatment of animals is defined by USDA FSIS (2020) as “an act or condition that results in severe harm to animals.” Egregious inhumane handling is further described by USDA FSIS (2020) as “1) Making cuts on or skinning conscious animals; 2) Excessive beating or prodding of ambulatory or nonambulatory disabled animals or dragging of

conscious animals; 3) Driving animals off semitrailers over a drop off without providing adequate unloading facilities (animals are falling to the ground); 4) Running equipment over conscious animals; 5) Stunning of animals and then allowing them to regain consciousness; 6) Failing to immediately (or promptly) render an animal unconscious after a failed initial stunning attempt (e.g., no planned corrective actions); 7) Multiple ineffective stun attempts (2 or more) that are due to one or more of the following establishment failures to properly handle or stun the animal: a) Failure to immediately (or promptly) apply the corrective actions that demonstrates a blatant disregard for animal discomfort and excitement; b) Failure to adequately restrain an animal; c) Failure to use adequate stunning methods (e.g., inadequate air pressure, inadequate caliber, insufficient electric current) for the animal being stunned (e.g., species of animal, size of animal, etc.); d) Poorly trained/untrained operator or inexperienced operator; or Prolonged discomfort and excitement of the animal due to the inability to render it insensible/unconscious after the application of the immediate (or prompt) corrective actions); 8) Dismembering conscious animals, for example, cutting off ears or removing feet; 9) Leaving disabled livestock exposed

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to adverse climate conditions while awaiting disposition; 10) Otherwise causing unnecessary pain and suffering to animals, including situations on truck.”

The North American Meat Institute (NAMI) describes that good handling principles are similar across species and take animals’ natural behaviors into account (NAMI, 2021). Additionally, eight actions are described as egregious and inhumane acts toward animals: 1) dragging a sensible animal; 2) intentionally applying electric prods to sensitive areas (e.g., face, udders, and genitalia); 3) intentionally slamming gates on animals; 4) driving ambulatory animals on top of one another or intentionally driving animals off high ledges; 5) hitting or beating an animal; 6) animals being frozen to the floor or sides of a trailer; 7) lifting a sheep by their wool or throwing a sheep. It is a legal requirement that all animals are rendered insensible prior to the start of slaughter procedures, with the exception of ritual slaughter (9 CFR 313) (United States Electronic Code of Federal Regulations, 2022a). Four methods of stunning are discussed in 9 CFR 313 (United States Electronic Code of Federal Regulations, 2022a): chemical – CO₂, mechanical – captive bolt, mechanical – captive bolt, and electrical – electric current. In addition, the American Veterinary Medical Association (AVMA) describes there are three main mechanisms which facilitate humane stunning for mammals: physical disruption of brain activity (methods: captive bolt, gunshot), direct depression of neurons responsible for cardiac and respiratory function (methods: CO₂), and electrical disruption of brain activity (methods: electrical stunning) (AVMA, 2016). It is important to note that each of these methods must reliably render an animal of a given specie immediately insensible to be considered a humane method for stunning that specie. It is a federal regulation that all animals are insensible before they are shackled, hoisted, thrown, cast, or cut (9 CFR 313) (United States Electronic Code of Federal Regulations, 2022a).

To ensure that slaughter establishments comply with the Humane Methods of Slaughter Act, they are subject to inspection under the jurisdiction of the United States Department of Agriculture Food Safety and Inspection Service (USDA FSIS, 2022a). Located within each slaughter establishment are Inspection Program Personnel (IPP); these individuals are tasked with observing day-to-day operations and are stationed such that they can observe all handling and stunning procedures (USDA FSIS, 2022a). The number of IPP at an establishment varies dependent upon the scale of the operation and rate of production. At a given establishment, IPP report to the Inspector in Charge (IIC) at that establishment; in small and very small establishments there may be a single IPP who is also the IIC.

An egregious act associated with the handling or stunning of livestock is a failure to comply with the Humane Methods of Slaughter Act (7 USC 1901) and supporting regulation (9 CFR 313) that results in the issuance of a Humane Handling Enforcement Action (HHEA) (USDA FSIS, 2020, 2022a). When an egregious humane handling violation occurs and is observed by an IPP, the issue is escalated to either the IIC or Public Health Veterinarian (PHV) (USDA FSIS, 2020). The notified individual (IIC or PHV) will stop the egregious act from continuing by taking regulatory control action (i.e., placing a retain tag on the stunner, restraint area, or handling area) (USDA FSIS, 2020). In instances where additional animals are likely to be impacted negatively (i.e., inhumane handling would occur), the PHV consults with the District Manager to consider a delay in the implementation of the suspension until any animals on-site

are either slaughtered or kept in lairage and animals in-transit have been redirected to another location or received and kept in lairage (USDA FSIS, 2020).

Following a humane handling incident and the regulatory control action, establishment management is verbally notified by the IIC or PHV (USDA FSIS, 2020). At the same time the IIC discusses appropriate corrective action with their respective district office, where DVMSs are headquartered (USDA FSIS, 2020). The number of DVMSs varies between districts. There are 10 district offices throughout the United States and each slaughter establishment is categorized into a district based on the state where it is located (USDA FSIS, 2022b). Ultimately, it is the District Manager who determines the enforcement action to take in compliance with 9 CFR 500 (United States Electronic Code of Federal Regulations, 2022b).

Depending on severity of the alleged humane handling violation, FSIS may issue a Notice of Intended Enforcement (NOIE) or a Notice of Suspension (NOS). A NOIE acts as a warning that FSIS has reason to suspend inspection but gives the establishment an opportunity to resolve the problem by corrective action without suspension. If a NOIE is not adequately addressed within 3 business days, FSIS may escalate the NOIE to a NOS. When a suspension is issued, all FSIS inspection is ceased until appropriate corrective actions are made by the slaughter establishment and then approved by an establishment’s corresponding district office (9 CFR 500) (United States Electronic Code of Federal Regulations, 2022b).

Follow-up actions to HHEAs include two primary options: deferral or abeyance. Deferrals are issued from the district office when an establishment with a NOIE has proposed acceptable corrective and preventative actions. Abeyances are issued following a NOS or Reinstatement of Suspension (ROS) when an establishment has proposed acceptable corrective and preventative actions. When an abeyance has been issued, inspection can resume, and the establishment may operate under mutually agreed upon conditions (9 CFR 500) (United States Electronic Code of Federal Regulations, 2022b). An abeyance may be stated in one of two ways: NOS held in abeyance or ROS held in abeyance (USDA FSIS, 2018). It is important to note that after a follow-up action has been issued, FSIS may issue a NOS (in the case of a previous NOIE) or ROS (in the case of a previous NOS) if an establishment does not adequately address the humane handling concerns or if new concerns arise (USDA FSIS, 2018).

Currently, there is no peer-reviewed literature to characterize HHEAs issued by FSIS. Annual articles have been published in industry publications but contain limited information (Anderson et al., 2020; Olsen et al., 2021; Vogel, 2019, 2021). The investigation of HHEAs is important because it facilitates the isolation of root causes behind HHEAs and informs the subsequent steps to address these root causes and prevent egregious acts during the handling and stunning of livestock. As such, the objective of this study was to systematically analyze and describe USDA FSIS HHEAs issued between 2018 and 2020.

MATERIALS AND METHODS

Enforcement Action Access

All HHEAs, and their respective follow up actions, were accessed from the USDA’s FSIS website (<https://www.fsis.usda.gov/inspection/regulatory-enforcement/humane-handling-enforcement>) within 1 yr of the date of posting to the aforementioned website.

Enforcement Action Assessment

For each HHEA letter, a two-reviewer assessment was performed. The following information was assessed by the primary reviewer and recorded in an Excel spreadsheet (Microsoft Corp., Spokane, WA). A secondary reviewer checked each entry to confirm accuracy in reporting by the primary reviewer. For each HHEA letter, the primary reviewer was a trained undergraduate student; the secondary reviewer was either a different trained undergraduate student or one of the authors. Disagreement between the two reviewers for any of the criteria was resolved via consensus after discussion with KDV or KNA.

1. The date of the HHEA.
2. The establishment number where the event occurred.
3. The FSIS district where the establishment was located (i.e., what district office issued the enforcement action).
 - Options: Alameda, Atlanta, Chicago, Dallas, Denver, Des Moines, Jackson, Philadelphia, Raleigh, Springdale
4. The type of regulatory action issued.
 - Options: NOS, ROS, NOIE
5. The reason for the enforcement action.
 - a. Options: Facility, Handling, Stunning, Multiple
 - b. If the reason was stunning, the type of stun.
 - Options: CO₂, Electrical, Mechanical, No Stun (Ritual Slaughter)
- i. If the type of stun was mechanical, the method of mechanical stun.
 - Options: Captive Bolt, Gunshot, Combination, Not Reported

- c. If the reason was stunning, the reason for stun failure.
 - Options: Equipment, Placement, Restraint, Time to Stick, Not Reported
6. The species involved in the enforcement action.
 - Options: Animal, Bison, Bovine, Caprine, Ovine, Porcine, Multiple
7. The type of follow up action (This information was accessed via the follow up letter associated with each enforcement action).
 - Options: Abeyance, Deferral

Statistical Analysis

The pivot table function of Excel (Microsoft Corp., Spokane, WA) was used to calculate summary statistics (proportion and %). Statistical models were not applied to the dataset because the entire population of enforcement actions were assessed, resulting in no unknown outcomes to predict.

RESULTS AND DISCUSSION

From 2018 to 2020, a total of 293 HHEAs were issued by FSIS in response to alleged violations of the Humane Methods of Slaughter (7 USC 1901) (United States House of Representatives Office of the Law Revision Council, 2022) and the regulations that enforce it (9 CFR 313) (United States Electronic Code of Federal Regulations, 2022a); 109 of those HHEAs were issued in 2018, 85 were issued in 2019, and 99 were issued in 2020.

An overview of HHEAs issued each year, as well as across the three years, can be observed in Table 1. In 2018, the

Table 1. Occurrence of HHEAs by species from 2018 to 2020

Species	Year			
	2018	2019	2020	2018–2020
	% (No./total)	% (No./total)	% (No./total)	% (No./total)
Animal (not specified)	3.67 (4/109)	2.35 (2/85)	2.02 (2/99)	2.73 (8/293)
Bison	0.92 (1/109)	0 (0/85)	0 (0/99)	0.34 (1/293)
Bovine	42.20 (46/109)	52.94 (45/85)	48.48 (48/99)	47.44 (139/293)
Caprine	0.92 (1/109)	2.35 (2/85)	1.01 (1/99)	1.37 (4/293)
Multiple	0 (0/109)	0 (0/85)	1.01 (1/99)	0.34 (1/293)
Ovine	6.42 (7/109)	5.88 (5/85)	11.11 (11/99)	7.85 (23/293)
Porcine	45.87 (50/109)	36.47 (31/85)	36.36 (36/99)	39.93 (117/293)

Percentage totals within each year add to 100.00% ± 0.01% due to rounding.

Table 2. Occurrence of HHEAs by type of regulatory action from 2018 to 2020

Type of regulatory action ^a	Year			
	2018	2019	2020	2018–2020
	% (No./total)	% (No./total)	% (No./total)	% (No./total)
NOS	57.80 (63/109)	56.47 (48/85)	59.60 (59/99)	58.02 (170/293)
ROS	19.27 (21/109)	23.53 (20/85)	22.22 (22/99)	21.50 (63/293)
NOIE	22.94 (25/109)	20.00 (17/85)	18.18 (18/99)	20.48 (60/293)

^aNOS, Notice of Suspension; ROS, Reinstatement of Suspension; NOIE, Notice of Intended Enforcement.

majority (45.87%; 50 of 109) of HHEAs involved the porcine species; in 2019 and 2020, the majority (52.94%; 45 of 85, 48.48%; 48 of 99, respectively) of HHEAs involved bovines. Across all three years, bovines were involved in the majority (47.44%; 139 of 293) of HHEAs. The total slaughter volume for the porcine and bovine species exceeded the total slaughter volume of all other red meat species during the duration of this study (USDA NASS, 2019, 2020; 2021). In 2018, 32.4 million cattle and 123.3 million hogs were slaughtered (USDA NASS, 2019). In 2019, 32.9 million cattle and 128.7 million hogs were slaughtered (USDA NASS, 2020). In 2020, 32.4 million cattle and 132.0 million hogs were slaughtered (USDA NASS, 2021). The greater prevalence of bovine and porcine related HHEAs during the time period of this study may be partially attributable to the proportionately-greater slaughter volume for those respective species. However, the relationship between annual species slaughter volume and number of HHEAs per species was not direct because bovine-related HHEAs exceeded porcine-related HHEAs in 2019 and 2020.

The breakdown of regulatory action type can be observed in Table 2. Each year the majority (2018 – 57.80%, 63 of 109; 2019 – 56.47%, 48 of 85; 2020 – 59.60%, 59 of 99) of HHEAs issued were NOSs. Between 2018 and 2020, 79.7% (233 of 293) of HHEAs resulted in the cessation of inspection by FSIS until corrective actions were made and approved by the appropriate district office. Of all enforcement actions between 2018 and 2020, 58.20% (170 of 293) were NOSs and 21.50% (63 of 293) were ROSSs. The remaining 20.48% (60 of 293) of enforcement actions issued during this time were NOIEs. A NOIE does not result in the complete cessation of suspension like a NOS or ROS; rather it indicates that FSIS has reason to suspend inspection if an establishment does not rectify the problem within 3 business days.

Table 3 contains a breakdown of the causes for HHEAs, along with the species involved. Most (85.67%; 251 of 293) HHEAs were related to stunning across the three years. Casagrande et al. (2020) described that the majority of HHEAs in slaughter establishments were related to stunning, which aligns with our findings. In 2018, the majority (40.37%; 44 of 109) of HHEAs were related to stunning of the porcine species. In 2019 and 2020, the majority (44.71%; 38 of 85 and 42.42%; 42 of 99, respectively) of HHEAs were related to the stunning of bovines. Across the three years, the majority (39.93%; 117 of 293) of HHEAs were related to the stunning of bovines.

Table 4 provides an overview of the species involved in HHEAs within each FSIS district. Across all three years, most HHEAs were associated with the bovine species with the exceptions of the Chicago, Jackson, and Springdale districts, which each issued more porcine-related HHEAs.

The breakdown of stun type, along with species, within stunning related HHEAs can be observed in Table 5. For all three years, the majority of stunning-related HHEAs involved the mechanical stunning of bovines (2018: 41.57%; 37 of 89, 2019: 50.67%; 38 of 75, 2020: 48.28%; 42 of 87, 2018-2020: 46.61%; 117 of 251). Recently, there has been a growing body of literature on differing aspects of mechanical stunning for cattle, specifically investigating technical aspects of stunning and the relationship to brain damage: impacts of pneumatic PCB bolt length on brain damage in a fed cattle slaughter establishment (Kline et al., 2019; Wagner et al., 2019); impacts of a single stun and a two-stun (single stun, plus security stun) on brain damage and hemorrhage in fed cattle (Casagrande et al., 2020). This growing body

Table 3. Occurrence of reasons for HHEAs from 2018 to 2020^{a,b}.

	2018 (n = 109)			2019 (n = 85)			2020 (n = 99)			2018–2020 (n = 293)		
	H	M	% (No./total)	H	M	% (No./total)	H	M	% (No./total)	H	M	% (No./total)
Animal (not specified)	0.92 (1/109)	0.92 (1/109)	1.83 (2/109) 0 (0/109)	0 (0/85)	2.35 (2/85)	0 (0/85) 0 (0/85)	0 (0/99)	0 (0/99)	0 (0/99)	0.34 (1/293)	1.02 (3/293)	1.02 (3/293) 0.34 (1/293)
Bison	0 (0/109)	0 (0/109)	0.92 (1/109) 0 (0/109)	0 (0/85)	0 (0/85)	0 (0/85) 0 (0/85)	0 (0/99)	0 (0/99)	0 (0/99)	0 (0/293)	0 (0/293)	0 (0/293) 0 (0/293)
Bovine	8.26 (9/109)	0 (0/109)	33.94 (37/109) 0 (0/109)	7.06 (6/85)	1.18 (1/85)	44.71 (38/85) 0 (0/85)	5.05 (5/99)	1.01 (1/99)	42.42 (42/99)	6.83 (20/293)	0.68 (2/293)	39.93 (117/293) 0 (0/293)
Caprine	0.92 (1/109)	0 (0/109)	0 (0/109) 0 (0/109)	0 (0/85)	0 (0/85)	2.35 (2/85) 0 (0/85)	0 (0/99)	0 (0/99)	1.01 (1/99)	0.34 (1/293)	0 (0/293)	1.02 (3/293) 0 (0/293)
Multiple	0 (0/109)	0 (0/109)	0 (0/109) 0 (0/109)	0 (0/85)	0 (0/85)	0 (0/85) 0 (0/85)	0 (0/99)	0 (0/99)	1.01 (1/99)	0 (0/293)	0 (0/293)	0.34 (1/293) 0 (0/293)
Ovine	1.83 (2/109)	0 (0/109)	4.59 (5/109) 0 (0/109)	1.18 (1/85)	0 (0/85)	4.71 (4/85) 0 (0/85)	0 (0/99)	0 (0/99)	11.11 (11/99)	1.02 (3/293)	0 (0/293)	6.83 (20/293) 0 (0/293)
Porcine	5.50 (6/109)	0 (0/109)	40.37 (44/109) 0 (0/109)	0 (0/85)	0 (0/85)	36.47 (31/85) 0 (0/85)	4.04 (4/99)	1.01 (1/99)	31.31 (31/99)	3.41 (10/293)	0.34 (1/293)	36.18 (106/293) 0 (0/293)

^aH, handling; M, multiple; S, stunning; NR, not reported.

^bPercentage totals within each year add to 100.00% ± 0.01% due to rounding.

Table 4. Distribution of HHEAs across FSIS districts from 2018 to 2020^a

District	Species	Year			
		2018	2019	2020	2018–2020
		% (No./total)	% (No./total)	% (No./total)	% (No./total)
Alameda	Animal (not specified)	0.00 (0/10)	0.00 (0/9)	0.00 (0/6)	0.00 (0/25)
	Bison	0.00 (0/10)	0.00 (0/9)	0.00 (0/6)	0.00 (0/25)
	Bovine	60.00 (6/10)	55.56 (5/9)	33.33 (2/6)	52.00 (13/25)
	Caprine	10.00 (1/10)	0.00 (0/9)	0.00 (0/6)	4.00 (1/25)
	Multiple	0.00 (0/10)	0.00 (0/9)	0.00 (0/6)	0.00 (0/25)
	Ovine	0.00 (0/10)	33.33 (3/9)	16.67 (1/6)	16.00 (4/25)
	Porcine	30.00 (3/10)	11.11 (1/9)	50.00 (3/6)	28.00 (7/25)
	Animal (not specified)	20.00 (1/5)	10.00 (1/10)	0.00 (0/4)	10.53 (2/19)
Atlanta	Bison	0.00 (0/5)	0.00 (0/10)	0.00 (0/4)	0.00 (0/19)
	Bovine	40.00 (2/5)	30.00 (3/10)	75.00 (3/4)	42.11 (8/19)
	Caprine	0.00 (0/5)	20.00 (2/10)	0.00 (0/4)	10.53 (2/19)
	Multiple	0.00 (0/5)	0.00 (0/10)	0.00 (0/4)	0.00 (0/19)
	Ovine	20.00 (1/5)	0.00 (0/10)	0.00 (0/4)	5.26 (1/19)
	Porcine	20.00 (1/5)	40.00 (4/10)	25.00 (1/4)	31.58 (6/19)
	Animal (not specified)	0.00 (0/14)	0.00 (0/7)	0.00 (0/12)	0.00 (0/33)
	Chicago	Bison	0.00 (0/14)	0.00 (0/7)	0.00 (0/12)
Bovine		28.57 (4/14)	42.86 (3/7)	66.67 (8/12)	45.45(15/33)
Caprine		0.00 (0/14)	0.00 (0/7)	0.00 (0/12)	0.00 (0/33)
Multiple		0.00 (0/14)	0.00 (0/7)	0.00 (0/12)	0.00 (0/33)
Ovine		7.14 (1/14)	0.00 (0/7)	0.00 (0/12)	3.03 (1/33)
Porcine		64.29 (9/14)	57.14 (4/7)	33.33 (4/12)	51.52 (17/33)
Animal (not specified)		33.33 (1/3)	33.33 (1/3)	0.00 (0/4)	20.00 (2/10)
Dallas		Bison	0.00 (0/3)	0.00 (0/3)	0.00 (0/4)
	Bovine	0.00 (0/3)	66.67 (2/3)	100.00 (4/4)	60.00 (6/10)
	Caprine	0.00 (0/3)	0.00 (0/3)	0.00 (0/4)	0.00 (0/10)
	Multiple	0.00 (0/3)	0.00 (0/3)	0.00 (0/4)	0.00 (0/10)
	Ovine	0.00 (0/3)	0.00 (0/3)	0.00 (0/4)	0.00 (0/10)
	Porcine	66.67 (2/3)	0.00 (0/3)	0.00 (0/4)	20.00 (2/10)
	Animal (not specified)	3.85 (1/26)	0.00 (0/13)	0.00 (0/21)	1.67 (1/60)
	Denver	Bison	3.85 (1/26)	0.00 (0/13)	0.00 (0/21)
Bovine		38.46 (10/26)	76.92 (10/13)	42.86 (9/21)	48.33 (29/60)
Caprine		0.00 (0/26)	0.00 (0/13)	4.67 (1/21)	1.67 (1/60)
Multiple		0.00 (0/26)	0.00 (0/13)	0.00 (0/21)	0.00 (0/60)
Ovine		7.69 (2/26)	0.00 (0/13)	23.81 (5/21)	11.67 (7/60)
Porcine		46.15 (12/26)	23.08 (3/13)	28.57 (6/21)	35.00 (21/60)
Animal (not specified)		0.00 (0/6)	0.00 (0/6)	0.00 (0/12)	0.00 (0/24)
Des Moines		Bison	0.00 (0/6)	0.00 (0/6)	0.00 (0/12)
	Bovine	50.00 (3/6)	83.33 (5/6)	33.33 (4/12)	50.00 (12/24)
	Caprine	0.00 (0/6)	0.00 (0/6)	0.00 (0/12)	0.00 (0/24)
	Multiple	0.00 (0/6)	0.00 (0/6)	0.00 (0/12)	0.00 (0/24)
	Ovine	0.00 (0/6)	0.00 (0/6)	16.67 (2/12)	8.33 (2/24)
	Porcine	50.00 (3/6)	16.67 (1/6)	50.00 (6/12)	41.67 (10/24)
	Animal (not specified)	0.00 (0/12)	0.00 (0/6)	0.00 (0/9)	0.00 (0/27)
	Jackson	Bison	0.00 (0/12)	0.00 (0/6)	0.00 (0/9)
Bovine		16.67 (2/12)	16.67 (1/6)	55.56 (5/9)	29.63 (8/27)
Caprine		0.00 (0/12)	0.00 (0/6)	0.00 (0/9)	0.00 (0/27)
Multiple		0.00 (0/12)	0.00 (0/6)	0.00 (0/9)	0.00 (0/27)
Ovine		25.00 (3/12)	16.67 (1/6)	11.11 (1/9)	18.52 (5/27)
Porcine		58.33 (7/12)	66.67 (4/6)	33.33 (3/9)	51.85 (14/27)

Table 4. Continued

District	Species	Year			
		2018 % (No./total)	2019 % (No./total)	2020 % (No./total)	2018–2020 % (No./total)
Philadelphia	Animal (not specified)	4.17 (1/24)	0.00 (0/12)	0.00 (0/5)	2.44 (1/41)
	Bison	0.00 (0/24)	0.00 (0/12)	0.00 (0/5)	0.00 (0/41)
	Bovine	54.17 (13/24)	50.00 (6/12)	80.00 (4/5)	56.10 (23/41)
	Caprine	0.00 (0/24)	0.00 (0/12)	0.00 (0/5)	0.00 (0/41)
	Multiple	0.00 (0/24)	0.00 (0/12)	0.00 (0/5)	0.00 (0/41)
	Ovine	0.00 (0/24)	0.00 (0/12)	0.00 (0/5)	0.00 (0/41)
	Porcine	41.67 (10/24)	50.00 (6/12)	20.00 (1/5)	41.46 (17/41)
Raleigh	Animal (not specified)	0.00 (0/8)	0.00 (0/13)	0.00 (0/14)	0.00 (0/35)
	Bison	0.00 (0/8)	0.00 (0/13)	0.00 (0/14)	0.00 (0/35)
	Bovine	62.50 (5/8)	53.85 (7/13)	42.86 (6/14)	51.43 (18/35)
	Caprine	0.00 (0/8)	0.00 (0/13)	0.00 (0/14)	0.00 (0/35)
	Multiple	0.00 (0/8)	0.00 (0/13)	7.14 (1/14)	2.86 (1/35)
	Ovine	0.00 (0/8)	7.69 (1/13)	7.14 (1/14)	5.71 (2/35)
	Porcine	37.50 (3/8)	38.46 (5/13)	42.86 (6/14)	40.00 (14/35)
Springdale	Animal (not specified)	0.00 (0/1)	0.00 (0/6)	16.67 (2/12)	10.53 (2/19)
	Bison	0.00 (0/1)	0.00 (0/6)	0.00 (0/12)	0.00 (0/19)
	Bovine	100.00 (1/1)	50.00 (3/6)	25.00 (3/12)	36.84 (7/19)
	Caprine	0.00 (0/1)	0.00 (0/6)	0.00 (0/12)	0.00 (0/19)
	Multiple	0.00 (0/1)	0.00 (0/6)	0.00 (0/12)	0.00 (0/19)
	Ovine	0.00 (0/1)	0.00 (0/6)	8.33 (1/12)	5.26 (1/19)
	Porcine	0.00 (0/1)	50.00 (3/6)	50.00 (6/12)	47.37 (9/19)

^aPercentage totals within each year add to 100.00% ± 0.01% due to rounding.

of literature reflects the need for continued refinement and validation of mechanical stunning methods and expansion to more diverse animal populations, such as those that have been culled from breeding or milk-producing herds. However, the existing literature does not fully address challenges that small and very small slaughter establishments may experience and there is a need for further research that pertains to the specific stunning-related challenges faced by small and very small slaughter establishments. [Thistlethwaite \(2020\)](#) indicated that small and very small slaughter establishments may lack the specialized equipment that is necessary to consistently and effectively stun a variety of species, as these establishments do not often specialize in a single species or type of animal.

[Table 6](#) provides an overview of the reasons for stun failure for electrical and mechanical stunning for the species that were involved with those types of stunning. Time to stick was the most common reason for failure with electrical stunning (32.00%; 8 of 25) across the three years for all species, when the reason for stun failure was clearly described in the HHEA. [Anil \(1991\)](#) reported that the time to stick must be less than 15 s following the completion of electrical stun application to ensure signs of return to sensibility are not observed in pigs that weigh 60 to 80 kg. [Wotton and Gregory \(1986\)](#) suggested the addition of cardiac arrest to head-only electrical stunning as a means to prevent return to sensibility in pigs. [Vogel et al. \(2011\)](#) described the relationship between slow post-shackling hoisting speeds and extended time to stick in small North

American slaughter establishments. They validated the application of a second electrical stun to the cardiac region following the initial application to the head of the pig as a practical solution for slaughter establishments that could not stick and induce bleeding within 15 s of electrical stunning ([Vogel et al., 2011](#)).

Placement was the most common reason for failure with mechanical stunning (31.92%; 68 of 213) for all species, when the reason for stun failure was clearly described in the HHEA. Deviation of more than 3 cm from a stunning location that consistently induces insensibility in cattle has been associated with greater incidence of return to sensibility in cattle ([Vecerek et al., 2020](#)). [Vecerek et al. \(2021\)](#) reported that the prevalence of deviations in stun location relative to a common target in the frontal location varied between cattle slaughter establishments. In addition, [Vecerek et al. \(2021\)](#) listed several studies that reported ineffective mechanical stunning in multiple countries. Specifically in the United States, [Galindo \(2019\)](#) reported that from January 2019 to September 2019, 46% of stunning related HHEAs involved 2 stuns, 38% involved 3 stuns, 13% involved 4 to 6 stuns, and 3% involved more than 6 stuns applied to a single animal. Multiple factors may have contributed to the number of ineffective stunning attempts, including placement, equipment performance, and operator training. There is a growing body of literature related to placement of mechanical stunning across species (Bovine: [Dewell et al. \(2016\)](#); [Gilliam et al. \(2012, 2016, 2018\)](#); [Robbins et al. \(2021\)](#); [Schiffer et al. \(2014\)](#);

Table 5. Occurrence of stun type by species from 2018 to 2020 for stunning related HHEAs^{a,b}

	Year																
	2018				2019				2020				2018-2020				
	% (No./total)				% (No./total)				% (No./total)				% (No./total)				
	CO ₂	E	M	NS	CO ₂	E	M	NS	CO ₂	E	M	NS	CO ₂	E	M	NS	
Animal (not specified)	0 (0/89)	0 (0/89)	2.25 (2/89)	0 (0/89)	0 (0/75)	0 (0/75)	0 (0/75)	0 (0/87)	0 (0/87)	0 (0/87)	1.15 (1/87)	0 (0/87)	0 (0/87)	0 (0/251)	0 (0/251)	1.20 (3/251)	0 (0/251)
Bison	0 (0/89)	0 (0/89)	1.12 (1/89)	0 (0/89)	0 (0/75)	0 (0/75)	0 (0/75)	0 (0/87)	0 (0/87)	0 (0/87)	0 (0/87)	0 (0/87)	0 (0/87)	0 (0/251)	0 (0/251)	0.40 (1/251)	0 (0/251)
Bovine	0 (0/89)	0 (0/89)	41.57 (37/89)	0 (0/89)	0 (0/75)	0 (0/75)	50.67 (38/75)	0 (0/87)	0 (0/87)	0 (0/87)	48.28 (42/87)	0 (0/87)	0 (0/87)	0 (0/251)	0 (0/251)	46.61 (117/251)	0 (0/251)
Caprine	0 (0/89)	0 (0/89)	0 (0/89)	0 (0/89)	0 (0/75)	0 (0/75)	1.33 (1/75)	0 (0/87)	0 (0/87)	0 (0/87)	1.15 (1/87)	0 (0/87)	0 (0/87)	0 (0/251)	0 (0/251)	0.80 (2/251)	0.40 (1/251)
Multiple	0 (0/89)	0 (0/89)	0 (0/89)	0 (0/89)	0 (0/75)	0 (0/75)	0 (0/75)	0 (0/87)	0 (0/87)	0 (0/87)	1.15 (1/87)	0 (0/87)	0 (0/87)	0 (0/251)	0 (0/251)	0.40 (1/251)	0 (0/251)
Ovine	0 (0/89)	0 (0/89)	5.62 (5/89)	0 (0/89)	0 (0/75)	0 (0/75)	5.33 (4/75)	0 (0/87)	0 (0/87)	2.30 (2/87)	10.34 (9/87)	0 (0/87)	0 (0/87)	0 (0/251)	0.80 (2/251)	7.17 (18/251)	0 (0/251)
Porcine	1.12 (1/89)	14.61 (13/89)	33.71 (30/89)	0 (0/89)	2.67 (2/75)	8.00 (6/75)	30.67 (23/75)	0 (0/87)	3.45 (3/87)	11.49 (10/87)	20.69 (18/87)	0 (0/87)	0 (0/87)	2.39 (6/251)	11.55 (29/251)	28.29 (71/251)	0 (0/251)

^aE, electrical; M, mechanical; NS, no stun.

^bPercentage totals within each year add to 100.00% ± 0.01 % due to rounding.

Caprine: [Plummer et al. \(2018\)](#); Porcine: [Anderson et al. \(2019, 2021, 2022\)](#); [Kramer et al. \(2021\)](#)). To ensure effective stunning and safeguard animal welfare, it is important that alternative placements which have not been validated are not used for mechanical stunning. Using validated stunning locations minimizes risk, and thus prevents HHEAs.

The breakdown of the method of mechanical stun, along with species, for all HHEAs which involved mechanical stunning in each year and across all three years can be observed in [Table 7](#). Mechanical stunning-related HHEAs were most common in bovine, ovine, and porcine species between 2018 and 2020. Within mechanical stunning methods, opportunities exist to investigate modifications that may improve stun efficacy, such as captive bolt length ([Kline et al., 2019](#)) and actions to prevent operator fatigue ([Wagner et al., 2019](#)).

A summary of establishments with multiple HHEAs can be observed in [Table 8](#). From 2018 to 2020, 293 HHEAs were issued to 196 slaughter establishments. Of these establishments, 36.22% (71 of 196) received two or more HHEAs. Further, 50.70% (36 of 71) of the establishments that received two or more HHEAs had HHEAs involving more than a single specie. The involvement of more than a single specie indicates that an establishment slaughters multiple species of animal and likely does not specialize in a specific type of animal (e.g., fed cattle, market hogs); small and very small establishments are more likely to slaughter multiple species than large establishments ([Thistlethwaite, 2020](#)). Additionally, 23.94% (17 of 71) of the establishments had two or more HHEAs that were issued for more than one reason (e.g., stunning and handling). Small and very small slaughter establishments are more likely to slaughter more than one species, unlike most large establishments, and as a result the number of establishments that received HHEAs that involved more than a single specie over the duration of this study may be partially indicative of establishment type or size ([Thistlethwaite, 2020](#)). These results suggest that small and very small establishments may require additional guidance and support to prevent HHEAs from occurring ([Thistlethwaite, 2020](#)).

IMPLICATIONS

This analysis of USDA FSIS HHEA letters issued between 2018 and 2020 provides valuable direction for efforts to address challenges in compliance with the Humane Methods of Slaughter Act and the regulations that enforce it. Specifically, stunning was the primary causative factor for most HHEAs and the majority of those HHEAs involved cattle and pigs. Analysis of establishments with repeated HHEAs indicated that multiple reasons and multiple species were involved in a substantial proportion of cases. These results suggest that small and very small establishments may require additional training and support as larger establishments tend to slaughter only a single specie. Additional detail and increased consistency in reporting – specifically, the species of animal should be clearly stated in all HHEAs, and if the HHEA is stunning related the specific stunning method, total number of stuns attempted, and the reason for stun failure should be clearly stated – the events that result in HHEAs from USDA FSIS would aid in guiding corrective actions on an industry-wide scale.

Table 6. Occurrence of reason for stun failure by stun type for electrical (ELEC) and mechanical (MECH) related HHEAs from 2018 to 2020^{a,c}

	Year																				
	2018				2019				2020				2018–2020								
	E	P	R	TTS	NR	E	P	R	TTS	NR	E	P	R	TTS	NR	E	P	R	TTS	NR	
ELEC^b	23.08 (3/13)	15.38 (2/13)	0 (0/13)	23.08 (3/13)	38.46 (5/13)	0 (0/6)	0 (0/6)	0 (0/6)	0 (0/6)	100.00 (6/6)	8.33 (1/12)	8.33 (1/12)	0 (0/2)	41.67 (5/12)	41.67 (5/12)	16.00 (4/25)	12.00 (3/25)	0 (0/25)	32.00 (8/25)	40.00 (10/25)	
Ovine	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/2)	0 (0/2)	0 (0/2)	100.00 (2/2)	100.00 (2/2)	0 (0/2)	0 (0/2)	0 (0/2)	0 (0/2)	100.00 (2/2)	
Porcine	23.08 (3/13)	15.38 (2/13)	0 (0/13)	23.08 (3/13)	38.46 (5/13)	0 (0/6)	0 (0/6)	0 (0/6)	0 (0/6)	100.00 (6/6)	10.0 (1/10)	10.0 (1/10)	0 (0/10)	50.0 (5/10)	50.0 (5/10)	17.39 (4/23)	13.04 (3/23)	0 (0/23)	34.78 (8/23)	34.78 (8/23)	
MECH	9.33 (7/75)	32.00 (24/75)	5.33 (4/75)	1.33 (1/75)	52.00 (39/75)	4.55 (3/66)	33.33 (22/66)	15.15 (10/66)	1.52 (1/66)	45.45 (30/66)	5.56 (4/72)	5.56 (4/72)	9.72 (7/72)	1.39 (1/72)	1.39 (1/72)	6.57 (14/213)	31.92 (68/213)	9.86 (21/213)	1.41 (3/213)	50.23 (107/213)	
Animal (not specified)	0 (0/2)	0 (0/2)	0 (0/2)	0 (0/2)	100.00 (2/2)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/1)	0 (0/1)	0 (0/1)	0 (0/1)	100.00 (1/1)	0 (0/3)	0 (0/3)	0 (0/3)	0 (0/3)	100.00 (3/3)	
Bison	0 (0/1)	100.00 (1/1)	0 (0/1)	0 (0/1)	0 (0/1)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/1)	100.00 (1/1)	0 (0/1)	0 (0/1)	0 (0/1)	
Bovine	13.51 (5/37)	32.43 (12/37)	2.70 (1/37)	0.00 (0/37)	51.35 (19/37)	5.26 (2/38)	36.84 (14/38)	13.16 (5/38)	2.63 (1/38)	42.11 (16/38)	7.14 (3/42)	7.14 (3/42)	11.90 (5/42)	2.38 (1/42)	2.38 (1/42)	8.55 (10/117)	34.19 (40/117)	9.40 (11/117)	1.71 (2/117)	46.15 (54/117)	
Caprine	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	100.00 (1/1)	0 (0/1)	0 (0/1)	0 (0/1)	0 (0/1)	0 (0/1)	0 (0/1)	100.00 (1/1)	0 (0/1)	0 (0/1)	50.00 (1/2)	0 (0/2)	50.0 (1/2)	0 (0/2)	0 (0/2)	
Multiple	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/1)	0 (0/1)	0 (0/1)	0 (0/1)	100.00 (1/1)	0 (0/1)	0 (0/1)	0 (0/1)	0 (0/1)	100.00 (1/1)	
Ovine	0 (0/5)	20.00 (2/5)	0 (0/5)	0 (0/5)	80.00 (4/5)	0 (0/4)	0 (0/4)	50.00 (2/4)	0 (0/4)	50.00 (2/4)	0 (0/9)	33.33 (3/9)	0 (0/9)	0 (0/9)	0 (0/9)	0 (0/18)	22.22 (4/18)	11.11 (2/18)	0 (0/18)	66.67 (12/18)	
Porcine	6.67 (2/30)	33.33 (10/30)	10.00 (3/30)	3.33 (1/30)	46.67 (14/30)	0 (0/23)	34.78 (8/23)	13.04 (3/23)	0 (0/23)	52.17 (12/23)	5.56 (1/18)	27.78 (5/18)	5.56 (1/18)	0 (0/18)	0 (0/18)	61.11 (11/18)	4.23 (3/71)	32.39 (23/71)	9.86 (7/71)	1.41 (1/71)	52.11 (37/71)

^aE, equipment; P, placement; R, restraint; TTS, time to stick; NR, not reported.^bElectrical stunning enforcement actions were only reported in the ovine and porcine species.^cPercentage totals within each year add to 100.00% ± 0.01% due to rounding.

Table 7. Distribution of mechanical stun method by species for HHEAs from 2018 to 2020^{a,b}

Year	2018					2019					2020					2018-2020				
	CB (n = 42)	GS (n = 17)	COMBO (n = 12)	NR (n = 4)	CB (n = 26)	GS (n = 22)	COMBO (n = 16)	NR (n = 1)	CB (n = 29)	GS (n = 34)	COMBO (n = 9)	NR (n = 0)	CB (n = 97)	GS (n = 73)	COMBO (n = 37)	NR (n = 5)				
Animal (not specified)	0.00 (0/42)	0.00 (0/17)	0.00 (0/12)	50.00 (2/4)	0.00 (0/26)	0.00 (0/22)	0.00 (0/16)	0.00 (0/1)	0.00 (0/29)	2.94 (1/34)	0 (0/9)	0.00 (0/0)	0.00 (0/97)	1.37 (1/73)	0.00 (0/37)	40.00 (2/5)				
Bison	0.00 (0/42)	0.00 (0/17)	8.33 (1/12)	0.00 (0/4)	0.00 (0/26)	0.00 (0/22)	0.00 (0/16)	0.00 (0/1)	0.00 (0/29)	0.00 (0/34)	0 (0/9)	0.00 (0/0)	0.00 (0/97)	0.00 (0/73)	2.70 (1/37)	0.00 (0/5)				
Bovine	47.62 (20/42)	70.59 (12/17)	33.33 (4/12)	25.00 (1/4)	69.23 (18/26)	54.55 (12/22)	43.75 (7/16)	100.00 (1/1)	55.17 (16/29)	58.82 (20/34)	66.67 (6/9)	0.00 (0/0)	55.67 (54/97)	60.27 (44/73)	45.95 (17/37)	40.00 (2/5)				
Caprine	0.00 (0/42)	0.00 (0/17)	0.00 (0/12)	0.00 (0/4)	0.00 (0/26)	0.00 (0/22)	0.00 (0/16)	0.00 (0/1)	0.00 (0/29)	2.94 (1/34)	0 (0/9)	0.00 (0/0)	0.00 (0/97)	1.37 (1/73)	2.70 (1/37)	0.00 (0/5)				
Multiple	0.00 (0/42)	0.00 (0/17)	0.00 (0/12)	0.00 (0/4)	0.00 (0/26)	0.00 (0/22)	0.00 (0/16)	0.00 (0/1)	3.45 (1/29)	0.00 (0/34)	0 (0/9)	0.00 (0/0)	1.03 (1/97)	0.00 (0/73)	0.00 (0/37)	0.00 (0/5)				
Ovine	11.90 (5/42)	0.00 (0/17)	0.00 (0/12)	0.00 (0/4)	7.69 (2/26)	4.55 (1/22)	0.00 (0/16)	0.00 (0/1)	24.14 (7/29)	5.88 (2/34)	0 (0/9)	0.00 (0/0)	14.43 (14/97)	4.11 (3/73)	0.00 (0/37)	0.00 (0/5)				
Porcine	40.48 (17/42)	29.41 (5/17)	58.33 (7/12)	25.00 (1/4)	23.08 (6/26)	40.91 (9/22)	50.00 (8/16)	0.00 (0/1)	17.24 (5/29)	29.41 (10/34)	33.33 (3/9)	0.00 (0/0)	28.87 (28/97)	32.88 (24/73)	48.65 (18/37)	20.00 (1/5)				

^aCB, captive bolt; GS, gunshot; BOTH, combination of CB and GS; NR, not reported.
^bPercentage totals within each year add to 100.00% ± 0.01% due to rounding.

Table 8. Occurrence of multiple HHEAs per establishment from 2018 to 2020

	% (No./total)
Total number of establishments	196
Establishments with 2+ HHEAs (repeat establishments)	36.22 (71/196)
Repeat establishments with 2+ species	50.70 (36/71)
Repeat establishments with 2+ reasons	23.94 (17/71)

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CONFLICT OF INTEREST STATEMENT

The authors declare no real or perceived conflicts of interest.

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