

Master of Public Health
Integrative Learning Experience Report

***THE CONNECTION BETWEEN FOOD SAFETY, PUBLIC
HEALTH, AND ANIMAL WELFARE***

by

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MASTER OF PUBLIC HEALTH

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Summary/Abstract

This report summarizes the online and in-person field experiences during the period from June of 2022 until January of 2023. The author interacted with various mentors from the United States and Europe to learn about food safety, public health, and animal welfare. Food safety and animal welfare standards and regulations, both national and international, are discussed as well as the connections of each to public health. The MPH competencies and the Food Safety and Biosecurity emphasis learning competencies were achieved through the field experience and coursework. The products created during the field experience include a presentation on the relationships between animal welfare, food safety and public health; a standardized Bison Harvest Plant audit tool; a blog article discussing food safety, animal welfare, and public health from a One Health perspective; and a *One Health Newsletter* reflection article on the 2022 International Mobility of Veterinary Students (iMOVES) hybrid learning experience.

Subject Keywords: online field experience, food safety, public health, animal welfare, livestock, bison, audit, reflection article, blog, iMOVES, multidisciplinary, One Health

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List of Abbreviations

APE	Applied Practical Experience
AHAW	(The European Union's) Panel on Animal Health and Welfare
CSU	Colorado State University
EFSA	European Food Safety Authority
EU	European Union
HACCP	Hazard Analysis and Critical Control Points
iMOVES	International Mobility of Veterinary Students
OIE	World Organization for Animal Health (Prior to May 2022)
RSA	Robust Systematic Approach
SOP	Standard Operating Procedures
SPS	Sanitary and Phytosanitary
SSOP	Sanitation Standard Operating Procedures
WOAH	World Organization for Animal Health (From May 2022-present)
WTO	World Trade Organization

Chapter 1 – Background: Food Safety, Public Health, and Animal Welfare

The reduction of stress in farmed animals is directly tied to improvements in animal welfare, meat quality, and the safety of the meat. It is no secret that increased stress in animals can lead to negative and often devastating consequences in meat and animal product quality and yield; however, it is not as widely known that the safety of the products may be compromised when animals experience stress.

Many animals carry foodborne pathogens in their digestive tracts; this can lead to cases of foodborne illness and disease. Common causes of stress include inadequate nutrition, deprivation of water and/or feed, extreme temperatures, overcrowding, acceptable and unacceptable handling of the animals, and transportation.

Stressors are influenced by intrinsic factors and stressor characteristics. Intrinsic factors are animal-related and include genetics, species, age, and past experiences with people. Stressor characteristics include variables including timing, avoidability, frequency, severity, and duration. (Lara and Rostagno, 2018). The most common factors of stress in farmed animals come as a result of normal activities that are a part of standard production practices. Animal practitioners should take certain precautions to reduce the risks of failure and keep the animals comfortable and calm.

Consumers often say that better animal welfare practices have a beneficial influence on food safety. However, the relationship is complex and inverse relationships may even be observed. Certain practices, while beneficial to animal welfare, can potentially negatively impact food safety. For this reason, continuous evaluations are encouraged, and balance must be achieved to achieve the best possible results. One such example of this complexity is the trade-off between animal welfare and food safety when providing outdoor access for food animals. While improving mental stimulation and adding enrichment to the lives of the animals, thus providing a positive increase to the welfare of the animals, it also exposes them to a variety of risks. Predators and adverse weather conditions (animal welfare risk) and potential exposure to pathogens and parasites (food safety risk) all are potential outcomes of outdoor access. Any of

these may also create negative welfare implications, while these may be direct or indirect, biosecurity risks such as pathogen exposure can lead to animal health consequences which can lead to food safety and human health issues.

An often-overlooked factor in improving food safety is the overall reduction in animal stress from handling and the environment. Research shows the value of appropriately using animal behavior to handle and move animals. Low-stress handling techniques are important to the experiences of these animals, and their stress responses as negative interactions with humans increase fear and confusion, thereby creating difficult handling and larger stress responses.

Understanding that the majority of the main food production animals in our systems are prey animals is crucial. Prey animals will demonstrate different behaviors and have different anatomical features than predators. Large fields of vision due to the position of the eyes on the sides of the head and a strong sense of smell are two examples that will allow handlers to understand the world as the animals in their care do. Pigs, for example, do not see the same range of colors that humans can.

Positive human-animal interactions and relationships between animals and people lead to more calm interactions throughout the entire production chain. Ensuring that these interactions are positive will decrease stress during handling and transportation as the animals grow accustomed to humans, movement, and handling procedures. These positive and negative experiences will be carried from the farm, into the transportation, and through to the production plant. This human-animal relationship is a crucial part of the Five Domains of animal welfare and has one of the largest impacts on the animals of any external factor.

Human-animal interactions likely to generate negative affects [examples]
<i>Persons near animals that have had little or no prior human contact</i> [Animals: rangeland, free-roaming and feral animals; wild-caught fish for display and other wildlife caught for use as pets.]
<i>Persons whose presence adds to already threatening circumstances</i> [Wildlife managers: trap-kill, trap-mark-release, capture-relocate; closely confined with no refuge; hands-on zoo visitor or tourist events. Livestock handlers: farmhands, transport drivers, sale yard staff, slaughterhouse workers. Veterinary care teams: veterinarians, veterinary nurses, animal attendants and owners.]
<i>Persons whose current actions are directly unpleasant, threatening and/or noxious</i> [Actions: psychological/physical abuse; serious mistreatment or neglect; physical restraint for aversive management or therapeutic procedures; aversive training methods; separation from dependently bonded companion animals; some veterinarians; riders whipping tired horses in sport.]
<i>Persons whose prior actions are remembered as being aversive or noxious</i> [Persons: intentionally cruel persons, unskilled trainers, unskilled animal handlers, stockpersons who apply routine noxious procedures, some researchers, some veterinarians, some farriers.]
<i>Bonded humans whose actions cause unintended harm</i> [Actions: affectionate displays seen as threatening by the animal; owners absent from bonded pets for long periods; owners delaying efficacious therapies; delayed end-of-life decisions for animals with compromised welfare.]
Human-animal interactions likely to generate positive affects [examples]
<i>The companionable presence of persons who provide company and feelings of safety</i> [Persons: Owners and/or caregivers whose animals are closely bonded to them, including companion, recreational, hobby farm, service, disability, breeder and other animals.]
<i>Persons who provide preferred foods, tactile contacts and/or training reinforcements</i> [Persons: companion animal owners, animal care staff; trainers using positive reinforcements; zoo staff using food enrichments.]
<i>Persons participating in enjoyable routine activities</i> [Activities: games, daily exercise, regular training.]
<i>Persons participating in engagingly variable activities</i> [Activities: diverse daily service functions, training schedules and/or opportunities for new experiences.]
<i>The calming presence of familiar persons in threatening circumstances</i> [Actions: hands-on gentling by persons strongly bonded to the animals.]
<i>Persons acting to end periods of deprivation, inhibition or harm</i> [Activities: delivering water, food, company and liberty from confinement.]

Figure 1. Human-Animal Interactions lead to positive and negative effects. (Mellor et.al, 2020).

At the production plants, well-known food safety and animal welfare mechanisms are in place including written programs and plans that utilize and include HACCP, SSOPs, SOPs, risk assessments, and RSAs. These written plans and management systems help identify, manage, and ultimately prevent risks before they become a reality.

One such management system is HACCP which, according to the FDA (2022), “is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product.” HACCP is the backbone of food safety plans in most modern processing facilities around the world today. HACCP includes seven principles in addition to program basics such as establishing prerequisite programs to build the program on, identifying a HACCP Team, education, describing the food and its intended use, creating flow diagrams, and others. Once the HACCP Plan is in place, the seven principles of HACCP can be applied to the products and steps in a production system to mitigate and respond to risk. The seven principles include the following:

1. Conduct a Hazard Analysis
2. Determine Critical Control Points (CCPs)
3. Establish Critical Limits
4. Establish Monitoring Procedures
5. Establish Corrective Actions
6. Establish Verification Procedures
7. Establish Record-Keeping and Documentation Procedures

Standard Operating Procedures (SOP's) and Sanitation Standard Operating Procedures (SSOP's) both standardize how procedures are performed in the production facilities. While SSOP's focus on the sanitation and subsequent food safety aspects of production and ensuring that equipment is clean, sanitized, and ready for production, SOP's may be related to food safety or other procedures that need to be written down to ensure that the integrity of the procedure is not lost or open to interpretation.

Risk assessments may also be used in food safety protocols or for animal welfare purposes. Identifying all potential risks in your system, even if they are not likely to occur, leads to a strong program. A risk assessment, along with written procedures (SOP's) are the backbone of a Robust Systematic Approach to animal welfare.

Even with these various management systems, standards, regulations, and programs in place, the power of consumer opinions and anthropomorphism—whether

based on scientific reasoning or not—continues to have a very high level of influence on all levels of government regulations than many experts. Studies show that products that are viewed as animal welfare approved or animal-friendly, are viewed as “healthier, safer, tastier, more hygienic, authentic, environmentally friendly, and traditional by many consumers” (Alonso et al., 2020). The European Food Safety Authority (EFSA) has scientific panels that are responsible for conducting and developing risk assessments where EU-wide approaches may not yet be in place or defined. One of these panels is the Animal Health and Welfare Panel (AHAW) that provides scientific advice from animal disease to animal health issues for terrestrial and aquatic food animals (EFSA, 2023).

The author’s Applied Practical Experience reflected on these relationships by participating in a variety of programs, including in-person, remote, and hybrid opportunities. These included traveling to Italy to participate in the global iMOVES program and to explore terrestrial and aquatic animal welfare and health implications, going to CSU and learning from Dr. Edwards-Callaway on bison behavior and stunning, and reflecting about my experiences through the creation of the blog and *One Health Newsletter* articles.

Chapter 2 - Learning Objectives and Project Description

During the Summer of 2022 through January of 2023, the author completed a hybrid field experience. The combination of programs and in-person experiences the author attended during the field experience included traveling to the University of Padova (iMOVES) and to Colorado State University to meet with my preceptor, Dr. Lily Edwards-Callaway, an Assistant Professor of Animal Science in the College of Agricultural Sciences at Colorado State University (CSU). She has extensive knowledge and experience in the field of Animal Welfare and in meat production. Dr. Edwards-Callaway received her M.S. in Animal Science from the University of Rhode Island, and her PhD in Animal Science - Livestock Behavior from CSU. Dr. Edwards-Callaway worked as an Assistant Professor of Livestock Behavior at Kansas State University for three years before working for JBS, one of the largest animal protein companies in the world, for years, as the Corporate Animal Welfare Manager for the Beef and Swine divisions. It was during this time that the author had the opportunity to work with Dr. Edwards-Callaway as a Humane Handling Manager at one of their Swine production facilities.

2.1 Learning Objectives:

1. To learn more about the relationship between public health, food safety, and animal welfare.
2. To gain a better understanding and first-hand experience of bison handling and slaughter practices.
3. To prepare and give a presentation to CSU students regarding the complex relationships between animal welfare, food safety, and public health.

2.2 Field Experience Activities:

1. The author attended the 2023 hybrid iMOVES course in June 2022. This two-week course included one week of remote learning, and a one-week program in-person at the University of Padova in Padua, Italy.
2. The author worked with the field experience mentor to visit a Bison processing plant in Colorado to observe the handling and stunning process.
3. The author created a standardized Bison processing plant audit based on the visit and other audits that are currently in use in the industry.
4. The author developed a presentation that discussed the relationships between animal welfare, food safety, and public health.
5. The author wrote a Reflection Article of the hybrid iMOVES field experience for the Kansas State University *One Health Newsletter*

6. The author wrote a blog article about the connections between animal welfare, public health, and food safety from a One Health perspective.

The accompanying Applied Practice Experience (APE) document specifies the various products developed throughout this field experience. These products include the following:

1. Portfolio product A: iMOVES Reflection Article for the *One Health Newsletter*
2. Portfolio product B: Presentation for CSU Graduate Students – Animal Welfare and Food Safety
3. Portfolio product C: Blog Article – Animal Welfare and Food Safety: A One Health Approach
4. Portfolio product D: Standardized Bison Harvest Audit

These four products appear in the appendix to this Integrated Learning Experience (ILE) report.

Chapter 3 - Reflection, Analysis, and Key Observations

The online and in-person field experiences created unique and independent learning opportunities for the author. In addition, the author's major advisor (Dr. Kastner) and the author have had regular meetings and discourse throughout the degree process and the field experiences. One theme remained strong throughout the APE, and this was that "protecting animal welfare and health is critical for maximizing productivity and efficiency as well as for reducing food safety risk, and consequently maintaining public health and consumer confidence" (Lara and Rostagno, 2018).

Portfolio Product A: iMOVES Reflection Paper

Background

The 2022 iMOVES hybrid learning experience covered terrestrial and aquatic animals and the food safety concerns regarding their use in our food systems. This reflection article focuses on the multidisciplinary coursework and the international speakers and experience gained.

Experiential Learning Gained Developing This Product

The author gained writing skills and analytical skills by combining the thoughts and experiences from her fellow scholars to create a concise article that could be easily reviewed and used as an advertisement for future students who are interested in participating in the program. The author created a survey asking specific questions from her peers, collected the responses, and then compiled the responses with additional course information and a program summary.

Portfolio Product B: Presentation for CSU Graduate Students – Animal Welfare and Food Safety

Background

During the last quarter of 2022, and thanks to an opportunity created by Dr. Edwards-Callaway, the author began working on a guest presentation for the CSU animal welfare graduate students. Several studies previously studying the effects of factors such as stress on the safety of the health of the animal, and the safety of the subsequent animal products were reviewed and discussed.

Consumer opinions were also analyzed. While the science has yet to clearly establish the relationship between animal welfare and food safety, the consumer opinion connects the two, especially regarding large-scale factory farming colloquially referred to as “factory farming.” The study conducted by Clark et al. (2019) showed the perceived risks and perceived benefits of intensive production systems. Of the top 10 risks, 8 of the 10 were regarding animal welfare, public health, and food safety.

While several studies were found, the results remained inconclusive regarding the severity of the effects across the studies. This shows that more research is required to show the same cause-effect relationship between stress and food safety that has been found between stress and food quality.

Experiential Learning Gained Developing This Product

While much of the research remained inconclusive and sometimes conflicting, the author was able to see the clear link between food safety, animal welfare, and public health through her research and hands-on learning experiences. This presentation for the CSU animal welfare graduate students was a great opportunity for delivering a thought-provoking, scientifically based talk.

Portfolio Product C: Blog – Animal Welfare and Food Safety: A One Health Approach

Background

During a meeting with Dr. Kastner, it was determined that a blog article focused on the effects animal welfare has on food safety and public health would be a good addition to the author's APE portfolio. This article, in conjunction with the author's work in the field of global food animal welfare, takes a One Health Approach to broadly discuss the links between public health, food safety, and animal welfare. The main aim of this article is to present the dynamic relationship between these three key components of the food system in ways that can be more readily understood.

Experiential Learning Gained Developing This Product

The author gained knowledge about writing for the general public and using an accessible writing style. Presentations of scientific research are often overly academic and off-putting to much of the population. Providing education and creating change is important and providing information that is accessible and readily digestible is an important educational tool to make a difference.

Portfolio Product D: Standardized Bison Harvest Audit Tool

Background

In May 2022, Dr. Kastner and the author met with Dr. Lily Edwards-Callaway from Colorado State University, a previous mentor of the author in the animal agriculture and meat industry, and she agreed to be a preceptor and assist with project ideas. During our initial meetings, we discerned that CSU was working with bison, and Dr. Edwards-Callaway expressed the need to create a standardized audit tool for the industry. There are a variety of standards covering farm-through-transport bison handling and processing, but not one that specifically covers harvest and stunning

processes. Without a plant standard specifically for bison, current North American Meat Institute (NAMI) standards or equivalent for cattle were being used in its place by a variety of companies and governmental agencies globally. Dr. Edwards-Callaway noted discrepancies between what some standards allowed and actual bison behavior. These standards are based on scientific research and are evaluated and updated by panels of industry members to ensure that outcome-based measures are established and audited. However, cattle behavior and bison behavior are different, and certain standards that apply to cattle do not apply or are not appropriate to use for evaluating bison.

Experiential Learning Gained Developing This Product

The author returned to visit CSU and a local processing plant that harvested different animal species, including bison. The author assisted in data collection and observed the process of handling, stunning, and sensibility. Through this visit, meetings with Dr. Edwards-Callaway and the graduate student project leader, analyzing the different North American bison audits and standards, conducting additional research about bison behavior and handling, and reviewing the NAMI Cattle and Calves Transportation and Slaughter audit tools and guidelines, the author was able to learn more about bison behavior and differences that need to be noted on a bison-specific audit for harvest plants.

Additionally, the author gained experience using the information provided, observed, and researched to gather information and make educated decisions to create a new audit tool that is more aligned with bison behavior. The bison guidelines and audit tools used included the following (see References section for full reference detail):

1. Global Animal Partnership's *5-Step® Animal Welfare Pilot Standards for Bison v1.1*
2. Global Animal Partnership's *5-Step® Animal Welfare Standards Audit Prep Tool for Bison v1.1*
3. *Humane Farm Animal Care Animal Care Standards for Bison*
4. National Farm Animal Care Council Code of Practice for the *Care and Handling of Bison*
5. American Humane Farm Program American Humane Certified™ *Bison Animal Welfare Standards Audit Tool*

Chapter 4 - Competencies and Noteworthy Coursework

Student Attainment of MPH Foundational Competencies

I am grateful for the dynamic classes that Kansas State offers that have allowed me to learn and grow in not only my academic career, but in my professional career through the following competency areas. There are 22 Public Health Foundational Competencies that I learned through my MPH program of study at Kansas State University. Through completing the individual courses, working directly with Dr. Kastner, and participating in my field experience projects, I was able to gain a better understanding of these competencies. This APE experience allowed me to further develop a select group of these competencies. Below, in Table 4.1, I describe and elaborate on how specific APE activities helped me grow in these competency areas.

Table 4.1 Summary of MPH Foundational Competencies Table

Number and Competency		Description (APE activity and/or product)
4	Interpret results of data analysis for public health research, policy, or practice	Analyzing different, currently-in-use Bison Animal Welfare and Handling processing plant audit tools and combining them with the experience gained from Bison processing plant visits to create one up-to-date and applicable audit handling tool and guidelines.
8	Apply awareness of cultural values and practices to the design or implementation of public health policies or programs	The iMOVES article discussed the cross-cultural values and practices that were in operation during the 2022 iMOVES food safety, animal welfare, and public health short course/field trip with the University of Padova.
12	Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence.	The Animal Welfare and Food Safety presentation for Colorado State University animal welfare graduate students described various aspects of understanding the link between

Number and Competency		Description (APE activity and/or product)
		animal welfare and food safety, including using peer-reviewed scientific research.
16	Apply principles of leadership, governance and management, which include creating a vision, empowering others, fostering collaboration and guiding decision making	The Animal Welfare and Food Safety presentation and the Blog regarding food safety and animal welfare discussed the links between the two previously not thoroughly researched themes.
22	Apply systems thinking tools to a public health issue	Food safety is a public health issue and animal welfare is directly tied to that in a variety of direct and indirect ways. The Bison Processing Plant Audit tool evaluates and compares and uses process mapping and a scoring rubric to evaluate the handling and stunning processes for Bison. The presentation on animal welfare and food safety explores the various links between animal welfare and food safety, food quality, food fraud, public health, and consumer opinions.

The author completed core MPH courses covering the competencies listed below in Table 4.2.

Table 4.2 MPH Foundational Competencies and Course Taught In

22 Public Health Foundational Competencies Course Mapping	MP H 701	MP H 720	MP H 754	MP H 802	MP H 818
Evidence-based Approaches to Public Health					
1. Apply epidemiological methods to the breadth of settings and situations in public health practice	x		x		
2. Select quantitative and qualitative data collection methods appropriate for a given public health context	x	x	x		

22 Public Health Foundational Competencies Course Mapping	MP H 701	MP H 720	MP H 754	MP H 802	MP H 818
3. Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate	x	x	x		
4. Interpret results of data analysis for public health research, policy or practice	x		x		
Public Health and Health Care Systems					
5. Compare the organization, structure and function of health care, public health and regulatory systems across national and international settings		x			
6. Discuss the means by which structural bias, social inequities and racism undermine health and create challenges to achieving health equity at organizational, community and societal levels					x
Planning and Management to Promote Health					
7. Assess population needs, assets and capacities that affect communities' health		x		x	
8. Apply awareness of cultural values and practices to the design or implementation of public health policies or programs					x
9. Design a population-based policy, program, project or intervention			x		
10. Explain basic principles and tools of budget and resource management		x	x		
11. Select methods to evaluate public health programs	x	x	x		
Policy in Public Health					
12. Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence		x	x	x	
13. Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes		x		x	x
14. Advocate for political, social or economic policies and programs that will improve health in diverse populations		x			x
15. Evaluate policies for their impact on public health and health equity		x		x	
Leadership					
16. Apply principles of leadership, governance and management, which include creating a vision, empowering others, fostering collaboration and guiding decision making		x			x
17. Apply negotiation and mediation skills to address organizational or community challenges		x			
Communication					
18. Select communication strategies for different audiences and sectors	DMP 815, FNDH 880 or KIN 796				
19. Communicate audience-appropriate public health content, both in writing and through oral presentation	DMP 815, FNDH 880 or KIN 796				
20. Describe the importance of cultural competence in communicating public health content		x			x
Interprofessional Practice					
21. Perform effectively on interprofessional teams		x			x
Systems Thinking					

22 Public Health Foundational Competencies Course Mapping	MP H 701	MP H 720	MP H 754	MP H 802	MP H 818
22. Apply systems thinking tools to a public health issue			x	x	

Student Attainment of MPH Emphasis Area Competencies

The author's emphasis area is Food Safety and Biosecurity in the Master of Public Health (MPH) program. The APE and the ILE were key elements in furthering her education regarding food safety and public health. She also learned about the interactions between food safety, public health, and animal welfare during her domestic and international field experiences. During these field experience activities and experiences, she reinforced and strengthened her knowledge and her work within the competencies, as shown in Table 4.3 below.

Table 4.3 Summary of MPH Emphasis Area Competencies

MPH Emphasis Area: Food Safety and Biosecurity		
Number and Competency		Description
1	Food safety and biosecurity	Food safety and biosecurity go hand-in-hand to protect everyday consumers and the food animals in our care. Therefore, there are various already-established standards and regulations across species, products, and regions to verify that every level in the production chain is covered with the goal of protecting human and animal health while minimizing production losses.
2	Threats to the food system	In addition to food safety, food defense, food fraud, and food security are very important concepts but are often the lesser-known or "forgotten" parts of the food protection pyramid as they are generally not

MPH Emphasis Area: Food Safety and Biosecurity		
Number and Competency		Description
		covered to the extent that food safety and quality are in the workplace; however, these threats are just as relevant. Protecting our food system at all levels and from a variety of possible risks is essential to protecting human and animal health. This is why national and international regulations and standards are critical pathways to risk mitigation.
3	Food safety laws and regulations	National and international laws, standards, and regulations are imperative to producing and providing safe food around the globe. The globalization of our food industry allows for more accessibility than ever before, but at what cost? International standards for scientific, food safety standards developed by the Codex Alimentarius Commission, the OIE/WOAH, the IPPC, and the WTO's SPS Agreement
4	Food safety policy and the global food system	Through the diverse coursework, I learned about our globalized food system and what the author calls the 6 F's: Food safety, Food quality, Food defense, Food fraud, Food protection, and Food security. The Food Safety and Biosecurity MPH emphasis is mostly focused on Food safety and protection (to include food defense, and food fraud) on a local and global level, and how the globalization of our food impacts its safety, and what we can do to mitigate the risks. Animal welfare

MPH Emphasis Area: Food Safety and Biosecurity		
Number and Competency		Description
		plays a role in the safety of animal products, whether it be due to pathogens, residues from medications, or zoonoses. Food animal biosecurity plays a large role in the safety of the food along the length of the spectrum; from farm-to-table.
5	Multidisciplinary leadership	The MPH program has provided the author with the multidisciplinary coursework necessary to gain a multidisciplinary perspective on food safety, public health, and animal welfare. The knowledge and leadership skills gained through the APE, along with my collaboration with my preceptors and different mentors throughout the various projects and experiences allowed me to grow in my leadership and take my knowledge and experiences and become a leader in my industry. I have used the experience, along with the knowledge gained about food safety standards in the United States, the EU, and Latin America to create suggestions, training initiatives, and provide leadership and support to companies around the globe looking to improve their animal welfare and food safety standards.

Noteworthy Coursework

The multidisciplinary coursework that Kanas State University's MPH program provides students, including this author, the freedom to explore the diverse connections and interactions between public health, food safety, and animal welfare. Three of the most memorable classes that the author participated in throughout the program

included Dr. Justin Kastner's Trade and Agricultural Health, Dr. Abbey Nutsch's Food Protection and Defense-Essential Concepts, and Dr. Abbie Viscardi's Animal Welfare course.

Trade and Agricultural Health centered around trade, the globalization of the food industry, food safety, animal health issues, and trade relations regarding these. Covering food safety standardization such as the Codex Alimentarius and the then OIE guidelines, this course went further into discussing the relevance of Trade and how SPS measures, "While often legitimately employed to protect public health, health protection measures [including SPS measures] can also simply be disguised barriers to trade" (Moy, 1999).

Dr. Nutsch's Food Protection and Defense-Essential Concepts was enlightening as it gave real world examples on a different side of the food system and food protection spectrum. Food defense and food fraud are unfortunately all too common in the food industry. The risks may be due to bioterrorism or fraud but are no less concerning. Whether through intentional tampering with food or ingredients, or by making false claims on products, which could lead to severe health consequences for consumers, food defense and food fraud are two very important parts of the puzzle that are often overlooked.

Dr. Viscardi's Animal Welfare course covered animal welfare principles for a variety of species—from farm animals to exotic animals—for veterinary students. Species-specific behaviors and challenges were discussed in-depth in each of the lessons, allowing for the extension of our knowledge outside of the common companion animals or large farm animal knowledge and experience that most of the students, including this author, have. During this course, a presentation was also required regarding an animal welfare concern in the industry today. I chose the ban on horse slaughter within the USA, and the welfare implications for equines due to that decision. This short presentation discussed broad themes regarding the consumer opinion and governmental roles and regulations that may have large effects on our lives and the lives of the billions of animals in our food and agricultural systems each year.

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Appendix – Portfolio Projects

Project A: iMOVES Reflection Article

iMOVES Summer 2022 Course: Food Safety, Public Health and Animal Welfare in Terrestrial and Aquatic Animals

Introduction

In June 2022, 6 students from the College of Veterinary Medicine as well as two faculty members participated in the 2022 cohort of the iMOVES (International Mobility of Veterinary Students) program hosted by the University of Padova in Italy. This specialized and intensive summer course focuses on a variety of topics that fall under the One Health umbrella including: food safety, aquatic and terrestrial animal welfare, and public health. The 2022 summer program marked the first year returning to in-person attendance after a two-year hiatus due to COVID-19. In 2020, the course was cancelled and in 2021 the course was 100% online via Zoom with use of online tools to encourage student participation.

The 2022 course, spearheaded by Professors Marco Patrino and Rudi Cassini from the University of Padova, followed in the footsteps of the past year and was a hybrid course that, through the continued use of videoconferencing tools, allowed for the participation of guest lecturers from around the globe. From June 6-10, 5 days of online learning opportunities from experts from Australia, Czech Republic, Italy, South Africa (Republic of South Africa, RSA), and the United States presented to the students.

When the in-person courses convened during the week of June 20, 2022, many additional experts from the University of Padova and Austria led thought-provoking lectures that included real-world examples and connections to veterinary medicine and one health. From foodborne pathogens to aquatic sustainability to zoo animal enrichment, iMoves continued to show the interdisciplinary thought processes and tools that are required to be successful.

This cross-cultural experience was eye-opening for many of the students and contributed greatly to their intellectual pursuits and to their future career paths. By design, the course allowed the students and faculty the ability to engage in thoughtful

discussions and cross boundaries that may ordinarily be in place simply from a geographical perspective.



Professor Justin Kastner (Kansas State University) providing insight into the history of the Palazzo Bo

Food Safety, Food Fraud, and Biosecurity

Food safety and biosecurity are two topics that were covered in depth, as well as alluded to, in multiple formats. Included in these discussions and lessons were *Seafood Related Illnesses*; *Control of Transmissible Diseases in Zoo*, The Illustrative Challenges of the Seafood Trade; Food-Borne Pathogens Overviews; Pathogenic Effects of Cetacean Parasites; and practical field visits to a poultry farm to learn about the impact zoonotic diseases such as Avian Influenza play and FIORITAL, a seafood processing company in Venice.

With the Avian Influenza affecting numerous countries, including Italy, protocols are regulations have been adjusted or put in place to continue to work to stop the spread and avoid biosecurity failings and missteps. For example, we were not allowed

to visit a farm that currently had live animals. The government also enacted regulations about distancing between new and current farms as the virus is airborne.

Food protection and food fraud were also discussed during one laboratory session where the students were asked to perform PCR (polymerase chain reaction) testing on cheese to determine food fraud of buffalo mozzarella. This one lab crosses the disciplines of chemistry, public health, and food safety.

At FIORITAL, we saw the process from beginning of the receipt of live crustaceans through to preparation, packaging, and testing in the laboratory for foodborne pathogens and toxins. As the last step between the producer and the consumer, it is imperative to complete routine and thorough testing to ensure that the food arrives to consumers in a condition that is not only safe to eat, but also enjoyable to eat.



Master of Public Health Student Snehale Gawhale participating in a laboratory class

Animal Welfare

“Animal Welfare requires the commitment to the...entire community, not just a single species.”

-Theresa Quintana

The wealth of knowledge regarding animal welfare, conservation, and sustainability from around the world included different perspectives on animal welfare and conservation, including the rarely discussed aspect of when animal welfare goes wrong. In the ongoing pursuit to improve the quality of life of animals around the world, many decisions that are taken with the goal of improving animal welfare have come to show they have quite opposite and even detrimental effects.

One of the most thought-provoking presentations on this topic came from Dr. Greg Vogt who discussed animal welfare challenges from a South African perspective. One of the most surprising was his recounting of the overpopulation of elephants in Kruger National Park due to the moratorium on culling put in place in the mid 1990's. According to Theresa Quintana, a graduate student in Public Health who attended the 2022 course, "as a result of the overabundance of elephants, other animals have suffered within the boundaries of the park due to environmental destruction and diminished resources. To control the population, the park began closing bore holes (man-made water sources) limiting water. While this was effective at reducing the elephant population growth, the management of the closures was haphazard at best, with no regard for the welfare of any of the animals in the park."

Animal welfare, as seen in the previous example, is a multifaceted theme and requires both broad and fine thinking. For this reason, it can also be directly and indirectly tied to animal health, the quality of the final products such as meat and eggs, and the overall safety of the products for human consumption. We must consider how we as humans have influenced the lives of the animals, including the inputs and outputs, and how we will continue to influence them. The good, the bad, current trends, new scientific findings, new laws and regulations, and production practices.

What are the good and the bad? While this a broad topic on its own as almost every process has a pro and a con, a good rule for evaluating good practices start with evaluating the animals based on the Five Freedoms of Animal Welfare and the Five Domains frameworks. For example, if we decide to end culling of elephants such as in the example provided by Dr. Vogt, we must evaluate the outcomes using animal-based

outcomes. One animal-based outcome is the overpopulation of the animals in a predetermined space (Kruger National Park) leading other animals to suffer from lack of resources. Thus, if we evaluate other animals in the park after the culling ban based of the Five Domains diagram shown below that was modified by the World Association of Zoos and Aquariums, many of these animals are having negative experiences in regard to Nutrition, Environment, Physical Health, and Behavior which then also negatively impacts their mental state leading to a negative welfare status. This includes the elephants themselves, as the man-made water holes were closed. So, rather than a quick and humane death, many animals struggled with no or limited to access to water (Nutrition), that affected all of the other domains and their mental state ultimately leading to a negative and potentially fatal outcome.

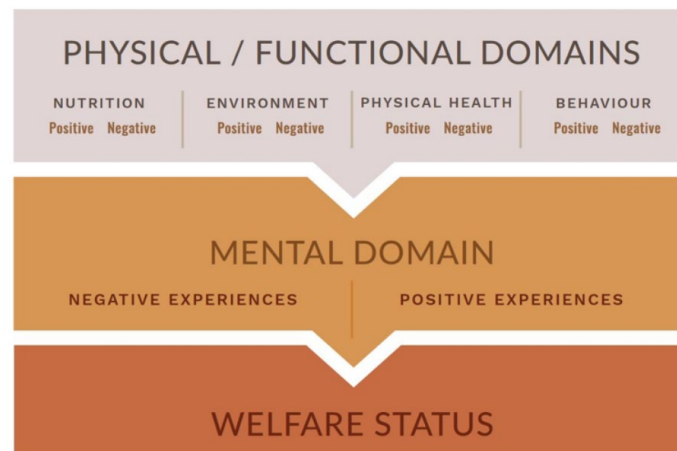


Image modified by WAZA from Mellor and Beausoleil 2015

800-Years of Education and One Health Initiatives

2022 marks the 800th birthday for the University of Padova (Padua) in Italy. This milestone, celebrating near a millennium of learning, showcases how the concept of One Health is not a new one. Connecting with students and teachers from around the world, all with the same common goals of seeking knowledge and participating in One Health initiatives, was one of the most noteworthy and important elements of this course.

“The iMOVES course is a multidisciplinary course that examines food safety, veterinary medicine, and public health practices and policy. It exemplifies how cross-

sector collaboration is needed to address, study, and monitor threats to public health,” says Emma Uridge, graduate student in Public Health.

The importance of multidisciplinary learning and collaboration is a cornerstone of this program, preparing students for future careers in veterinary medicine and public health fields. The emphasis on cross-discipline relationships was present in all courses and was encouraged by all educators during the sessions and field experiences. Even in the laboratory sections, the focus was on multiple areas and how One Health is present in everything.



Students visiting a poultry farm and learning the mitigations taken to prevent diseases, such as Avian Influenza.



Prof. Piccirillo (University of Padova, Italy) leading a dissection laboratory class

Closing

As an MPH student and as a professional currently working in the field of animal welfare, I have been and remain passionate about public health, animal welfare, and international collaboration. In the past few years of my studies, the emphasis on One Health has become even more apparent and at the forefront of much of my day-to-day life. While I have worked within the concept of One Health for many years, it was not until a few years ago that I became aware of what it was.

Walking the hallowed halls of the Palazzo Bo, visiting the world's oldest anatomical theater, which is known as the birthplace of modern medicine, and following in the footsteps of some of the world's most celebrated and inspiring thinkers such as Galileo and Lucrezia Cornaro Piscopia, offers the parallel in the way that modern students and scientists continue to push forward in our pursuit of knowledge. Just as students were attempting to unravel the mysteries of the human body four-hundred years ago, we are continuing in this tradition and now understand the importance of crossing disciplines in the process.

The CDC defines One Health as “a collaborative, multisectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment.” While our individual goals may differ between disciplines, just as our previous experiences and areas of interest during this course all differed slightly, the overall goals remain the same as it all comes down to Public Health. My goals for a career in international food safety and animal welfare are stronger than ever, and I can thank my multidisciplinary coursework in the MPH program for helping propel this. The MPH program is unique in that it is required to be multidisciplinary. I was able to take courses from different colleges within the university that all fit in and played off each other to round out my education. This is in direct contrast to so many programs that are centered in one field with very little outside influence.

Multidisciplinary studies and learning opportunities that focus on hands-on learning and interaction is what truly drives international, interdisciplinary, and intergenerational changes and makes this program stand out. The final comments from my fellow Kansas State classmates show the effects the course has had on our understanding of and passion to pursue One Health in our future careers. Theresa Quintana noted that, “As a future leader in public health, it was an important reminder that we cannot focus too closely on individuals if improving population health is the goal.” Elizabeth Buller remarked that, “this experience renewed my desire to work in public health and pursue international options.” Emma Uridge called it “a visceral and emotional experience.” Personally, I know that I will take the knowledge I have gained in the hopes of making a change and leaving the world a little better than I found it for both people and animals. It has also reminded me that life is too short not to take a moment from time to time to slow down and savor the gelato.



Bottom left, clockwise: Prof. Justin Kastner, Prof. Ellyn Mulcahy, Theresa Quintana, Lauren Davis, Elizabeth Buller, Emma Uridge, and Dr. Sarah Wilson in Venice, Italy. Not pictured: Snehal Gawhale

Sources:

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Project B: Presentation for CSU Graduate Students – Animal Welfare
and Food Safety



What do you think? —→

1. Food Quality
2. Food Fraud
3. Food Safety
4. Animal Welfare



What do you think? —→

1. Food Quality
2. Food Fraud
3. Food Safety
4. Animal Welfare



Food/Meat Quality

Numerous studies and evidence in all species

- PSE/DFD
- Woody breast/white streaking
- Purge
- Bruising
- Petechia hemorrhaging handling, mycotoxins
- Milk #s - somatic cell count (SCC)
- Egg/Shell quality - stress, disease, etc.



Food Safety

PATHOGENS

- Salmonella
- E. coli (generic and STEC)
- Campylobacter

ZOONOSIS THROUGH PRIONS

Bovine spongiform encephalopathy (BSE) aka "Mad Cow Disease" → Creutzfeldt-Jakob disease (vCJD) in humans

RESIDUES

- Drug withdrawals
- Antibiotics and antibiotic resistance
- Hormones

Food Fraud

- USDA Inspected
- Switching protein type
- No antibiotics ever
- Free from beta agonists
- Free Range
- Open Pen
- Animal Welfare Certified



Animal Welfare

"The physical and mental state of an animal in relation to the conditions in which it lives and dies."

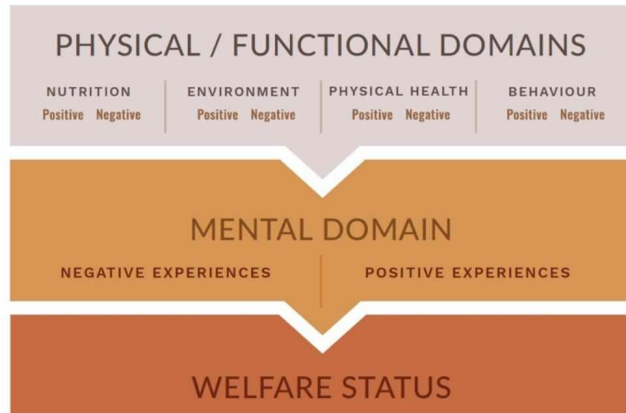
-WOAH

- 5 Freedoms
- 5 Domains
- Human-animal relationship/interactions
- Indicators
 - Direct vs. Indirect

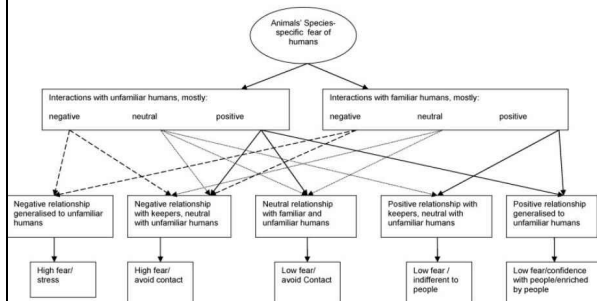
5 Freedoms



5 Domains



Human-Animal Interactions



Welfare indicators

Direct - Animals

Indirect - Outside factors

Ex: Environment, personnel, facilities, etc.



Biosecurity

Is it really Animal Welfare?

- A critical factor in protecting animals and ensuring not only their health and welfare, but also PUBLIC health and welfare
- Intensively farmed systems better or worse than traditional?



True Story

- A large processing plant in the USA (2022) had a large outbreak of influenza A brought in by pigs. The USDA ran tests and found it.
- Approximately 400 people became ill.

Seventy-five percent of all emerging human infectious diseases originate from animals (Taylor et al. 2001).

Stress -----

The real culprit?

- Immunosuppression
- Increased pathogen shedding
- Genetic selection



An animal's response to stress is the main mechanism through which poor welfare is translated into poor health and consequently to food safety problems (Humphrey, 2006; Rostagno, 2009)

The health status of food animals can potentially influence foodborne pathogen levels in three ways.

1. Diseased animals may shed higher levels of foodborne pathogens.
2. In the processing plant, carcasses that require removing affected parts may lead to increased microbial contamination and cross-contamination.
3. Certain animal illnesses may lead to a higher probability of mistakes in the processing plant, such as gastrointestinal ruptures, which would lead to increased contamination.

Singer, R.S., et al.

↓ Food animal illnesses
+ ↓ Bacterial contamination

= ↓ Human Illnesses

Stress -----

Case Study 1

Impacts of individual animal response to heat and handling stresses on Escherichia coli and E. coli O157:H7 fecal shedding by feedlot cattle

Tami M Brown-Brandl ¹, Elaine D Berry, James E Wells, Terrance M Arthur, John A Nienaber

Affiliations + expand

PMID: 19459757 DOI: 10.1089/fpd.2008.0222

Objective: Investigate the effects of heat and handling stress levels on the fecal shedding of Escherichia coli O157:H7 and generic E. coli by feedlot cattle.

- **Year 1:** 128 feedlot heifers were evaluated 5x week during the 84-day finishing period from May-August. Respiration rate, panting score, and visual assessment.
- **Year 2:** Panting scores were taken for a group of 256 finishing feedlot heifers on days in July and August for which the temperature humidity index was predicted to be in the "emergency" zone.
- Animals weighed, temperament scored, and rectal fecal samples taken individually for E. coli (O157:H7 and generic)

Stress -----

Case Study 1 Results

Impacts of individual animal response to heat and handling stresses on Escherichia coli and E. coli O157:H7 fecal shedding by feedlot cattle

Tami M Brown-Brandl ¹, Elaine D Berry, James E Wells, Terrance M Arthur, John A Nienaber

Affiliations + expand

PMID: 19459757 DOI: 10.1089/fpd.2008.0222

Results:

- **No clear trends** between the heat stress levels or temperament scores (as an indicator of response to handling) with either fecal generic E. coli or E. coli O157:H7 concentrations or prevalence in feces,
- This indicates that neither heat nor handling stress contributes to the food safety risk associated with E. coli O157:H7-positive cattle.

Stress -----

Factors Associated with Shiga Toxin-Producing Escherichia coli Shedding by Dairy and Beef Cattle

Case Study 2

Cristina Venegas-Vargas ¹, Scott Henderson ², Akanksha Khare ³, Rebekah E Mosci ³, Jonathan D Lehnert ³, Pallavi Singh ³, Lindsey M Ouellette ³, Bo Norby ¹, Julie A Funk ¹, Steven Rust ⁴, Paul C Bartlett ¹, Daniel Grooms ¹, Shannon D Manning ⁵

Affiliations + expand

PMID: 27342555 PMCID: PMC4968536 DOI: 10.1128/AEM.00829-16

Objective: Identify epidemiological factors associated with shedding of Shiga toxin-producing Escherichia coli (STEC)

- 1,096 cattle in 6 dairy herds (718) and 5 beef herds (378) over 2 summers to identify epidemiological factors associated with shedding.
- Fecal samples were obtained from each animal and cultured for STEC.
- Multivariate analyses were performed to identify risk factors associated with STEC.

Stress -----

Factors Associated with Shiga Toxin-Producing Escherichia coli Shedding by Dairy and Beef Cattle

Case Study 2 Results

Cristina Venegas-Vargas ¹, Scott Henderson ², Akanksha Khare ³, Rebekah E Mosci ³, Jonathan D Lehnert ³, Pallavi Singh ³, Lindsey M Ouellette ³, Bo Norby ¹, Julie A Funk ¹, Steven Rust ⁴, Paul C Bartlett ¹, Daniel Grooms ¹, Shannon D Manning ⁵

Affiliations + expand

PMID: 27342555 PMCID: PMC4968536 DOI: 10.1128/AEM.00829-16

- Prevalence was higher in beef cattle (21%) than dairy cattle (13%)
- Considerable variation across herds (range, 6% to 54%).
- Dairy cattle significantly more likely to shed when the average temp was >84 F, during their first lactation, and when they were <30 days in milk.

This suggests that the stress or the negative energy balance associated with lactation may result in increased shedding frequencies during warm months.

Case Study 3

Evaluation of Commercial β -Agonists, Dietary Protein, and Shade on Fecal Shedding of *Escherichia coli* O157:H7 from Feedlot Cattle

James E. Wells , Elaine D. Berry, Minseok Kim, Steven D. Shackelford, and Kristin E. Hales

Published Online: 1 Nov 2017 | <https://doi.org/10.1089/fpd.2017.2313>

Objective: Determine if the β -agonists ractopamine hydrochloride (RAC) or zilpaterol hydrochloride (ZH) would impact the level or prevalence of fecal *E. coli* O157:H7 shedding.

- Experiment 1: RAC fed + addition of dietary soybean meal (SBM)
- Experiment 2: ZH fed + addition of 30% (dry matter basis) wet distillers grains with solubles (WDGS)
- Experiment 3: ZH fed + addition of shade over the feedlot pens

Case Study 3 Results

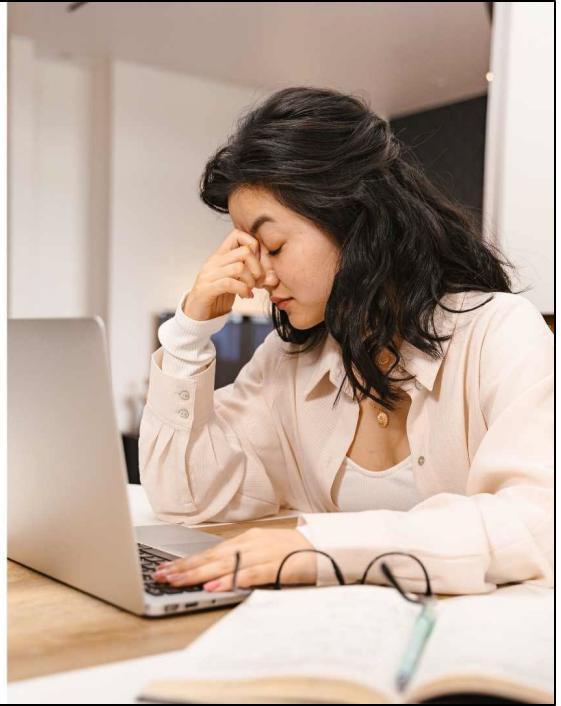
Evaluation of Commercial β -Agonists, Dietary Protein, and Shade on Fecal Shedding of *Escherichia coli* O157:H7 from Feedlot Cattle

James E. Wells , Elaine D. Berry, Minseok Kim, Steven D. Shackelford, and Kristin E. Hales

Published Online: 1 Nov 2017 | <https://doi.org/10.1089/fpd.2017.2313>

- Experiment 1: RAC fed + addition of dietary soybean meal (SBM)
 - RAC did not impact fecal shedding, addition of SBM did reduce *E. coli* shedding.
- Experiment 2: ZH fed + addition of 30% (dry matter basis) wet distillers grains with solubles (WDGS)
 - ZH did not affect shedding, but addition of WDGS tended to increase shedding.
- Experiment 3: ZH fed + addition of shade over the feedlot pens
 - ZH did not affect shedding, the presence of shade over the feedlot pens did not affect *E. coli* O157:H7 shedding.

The answer is
clear!

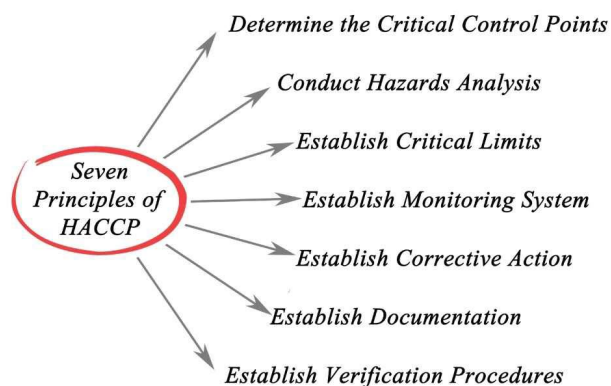


Clear as mud...



Food Safety & Animal Welfare: The Good News

- Government Requirements and Inspections
- Similarities between HACCP and AW plans
- You can use this guide to develop, write, and revise your program.



Risk Assessment						Date issued: 18 Aug 2020
						Revision Date:
						Revision #:
						Document Name: Risk Assessment
Production Step	Possible Hazard	CCP/POPA	Control measure	Critical Limit	Monitoring/Verification Procedure	Corrective Action
	Unsupervised unloading	1. Improper unloading practices 2. Improper trailer conditions	Unloading is to be supervised, gate locked	0% unsupervised unloadings without prior approval	Internal and/or remote auditing	Retraining and/or disciplinary action
	locked gates	1. Mixed animals. 2. Escaped animals.	Documentation procedures. Gates able to be securely latched.	100% gates properly closed, latched, and entry gate locked	Internal auditing and daily facility walks	Retraining, disciplinary action, or facility maintenance
	Water availability	Clean water should be supplied in all occupied holding pens 24/7	Provide water in all holding areas	100% areas that hold animals (15 min.+) have access to clean water 24/7	Internal and/or remote auditing	Water will be provided
	Facility Maintenance	Acceptable condition for receiving animals	Facility maintenance walkthroughs	100% of facilities are acceptable for receiving animals	Weekly facility condition walk	Repairs will be made before continuing to use area(s).
	Injury Points	No injury points	Internal auditing and daily facility walks	No injury points observed in the unloading area	Internal auditing and daily facility walks	Remove, fix, cover injury point before moving animals

The Government and Our Food

USDA - The U.S. Department of Agriculture
FSIS - Food Safety and Inspection Services
AMS - Agricultural Marketing Services
APHIS - Animal and Plant Health Inspection Service

1. Protects and promotes U.S. agricultural health, regulates genetically engineered organisms, administers the Animal Welfare Act, and manages wildlife damage.
2. Protects the public's health by ensuring that meat, poultry and egg products are safe, wholesome and properly labeled.
3. Provide leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy, the best available science, and effective management.
4. Administers programs that create domestic and international marketing opportunities for U.S. producers of food, fiber, and specialty crops.



What's for Lunch? School Lunch Program



APPROVED

Agricultural Marketing Service (AMS)
Livestock and Poultry (LP) Program
Standards and Specification Division (SSD)
Room 2628-S, STOP 0258
Phone: (202) 690-3148

FEDERAL PURCHASE PROGRAM SPECIFICATION (FPPS) FOR ANIMAL HANDLING AND WELFARE

Supersedes: FPPS-AHW-2020 November 2020 –
Changes from previous requirements in blue

Effective: March 2021

- 233. Animal Welfare Requirements
- 233.1 All eligible suppliers shall meet the animal handling and welfare requirements set forth in the FPPS for Animal Handling and Welfare, effective **March 2021 (Exhibit B)**.
- 241 For all species, animals/carcasses that are inspected and passed by the Food Safety Inspection Service (FSIS) are eligible for AMS purchase programs.
- 334.2 Pathogen Intervention Steps – The harvest process shall include at least two pathogen intervention steps. One of the intervention steps shall be a critical control point (CCP) in the establishment's FSIS recognized harvest process Hazard Analysis Critical Control Point (HACCP) plan.

What's for Lunch? Examples of Requirements Not Based On Food Safety

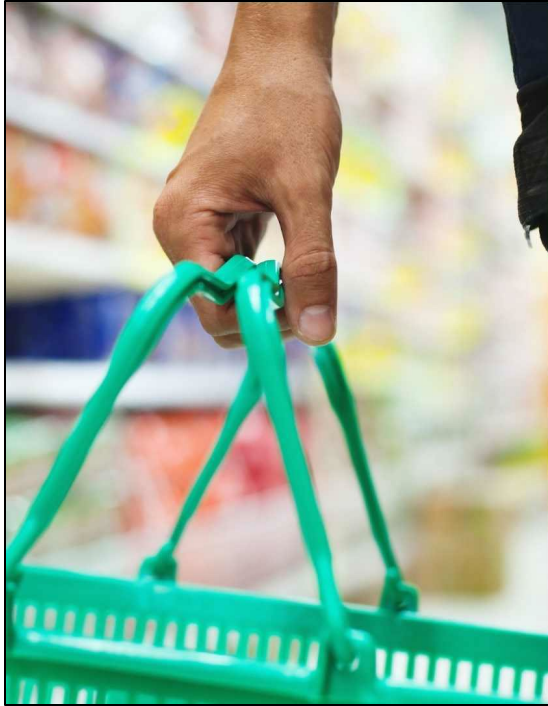


MECHANICALLY RECOVERED / RECLAIMED MEAT
Welcome to your HOT DOGS, LUNCH MEAT & BURGER

- 323.1 Humane Handling – All sows and/or hogs shall be humanely handled in accordance with all applicable FSIS regulations and AMS requirements.
- 324.5 Lean Quality – The pork leg muscles shall not exhibit any evidence of pale, soft, and/or exudative conditions.
- 221.3.2 Non-Ambulatory Hogs – Meat from carcasses of non-ambulatory hogs will not be included in USDA purchased boneless pork product.
- 325 Mechanical Separation - Pork that is mechanically separated from bone with automatic deboning systems or advanced lean (meat) recovery (AMR) systems is not allowed.

Do these mean the meat is unsafe?





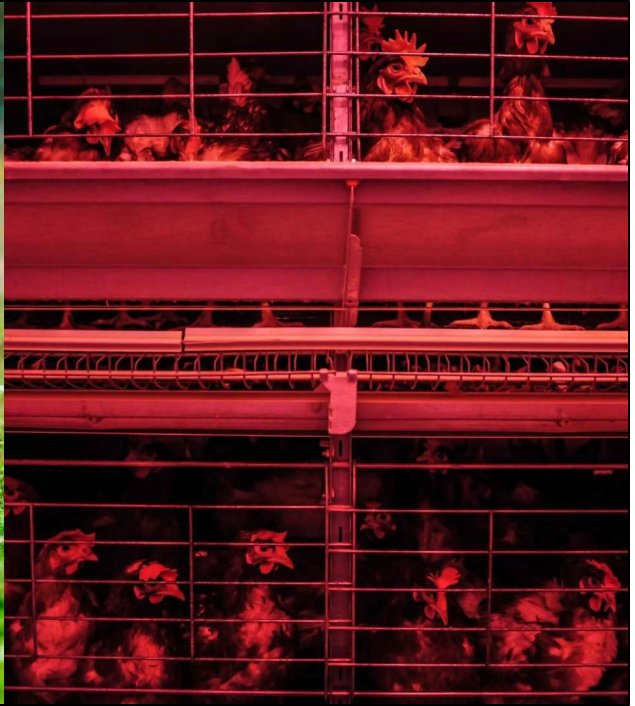
Consumer Perception

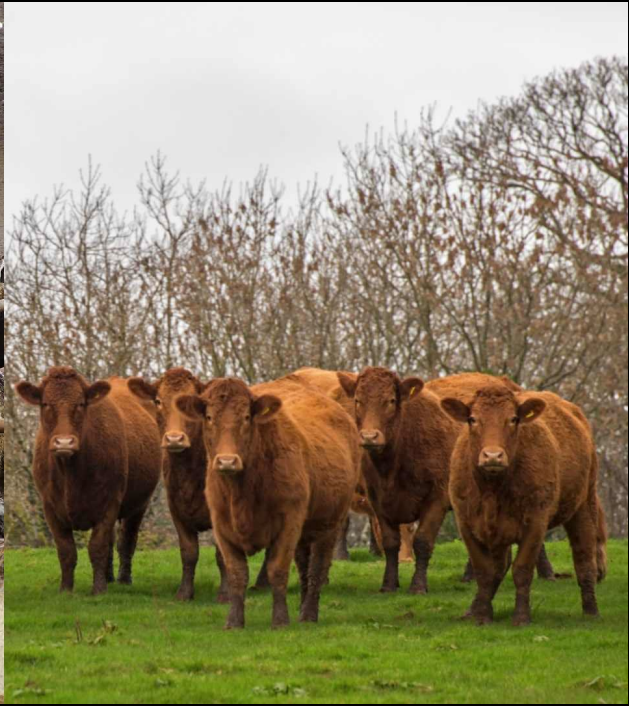
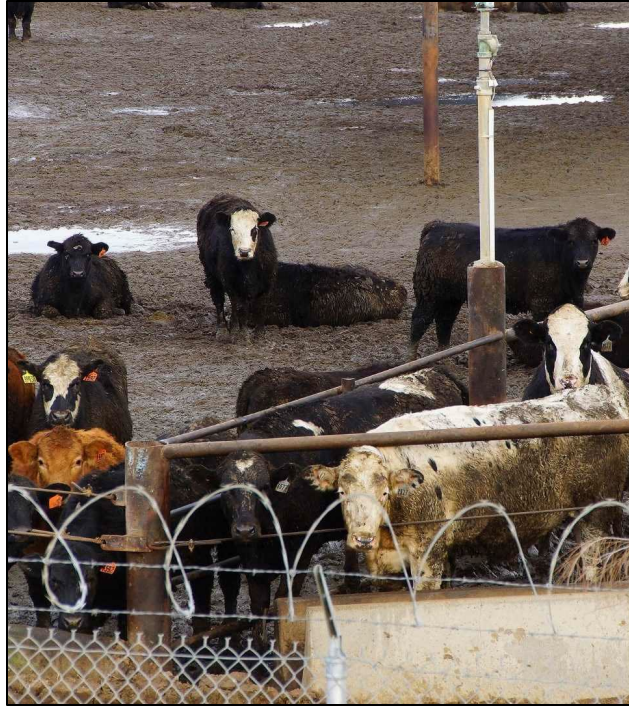
What's science got to do with it?

- From activists to government regulations... is everything based off science?
- Is "Intensive farming" synonymous with unethical or unsafe?
- Is "factory farming" better or worse for public health?

"Despite... having some of the most stringent animal health and welfare regulations globally, most groups of stakeholders were not trusted by respondents to provide reliable information about these systems, with respondents distrusting most supply chain stakeholders."

Clark, B. et al.





Perceived as a benefit			Perceived as a risk		
More cost-efficient production method	3.66 ± 1.07		Increased animal stress	3.88 ± 1.10	
Cheaper food of animal origin	3.65 ± 1.05		An unnatural production method	3.78 ± 1.10	***
Increased availability of animal based products	3.56 ± 1.03	★	Increased incidence of animal diseases	3.61 ± 1.08	
Greater protection from predators	3.42 ± 1.09	★★	Reduced human food quality	3.56 ± 1.07	
Greater protection from bad weather	3.41 ± 1.09	★★★	Compromised FAW monitoring	3.55 ± 1.06	
Benefits to agriculture	3.18 ± 1.14	★★★	Decreased consumer trust in food	3.51 ± 1.09	
More professionally run farms	3.12 ± 1.17	★★★	Reduced nutritional quality of food	3.50 ± 1.07	
Faster treatment of animal diseases	3.10 ± 1.20	★★★	Reduced human food safety	3.46 ± 1.08	
Benefits to consumers	3.07 ± 1.17	★★★	Negative effects on consumer health	3.42 ± 1.08	
Improved FAW monitoring	3.00 ± 1.25		An unsustainable approach to animal production	3.40 ± 1.05	
Improved human food safety	2.99 ± 1.25		Risks to consumers	3.34 ± 1.10	
Benefits to the environment	2.96 ± 1.17		Risks to your family	3.33 ± 1.11	
A more sustainable approach to animal production	2.89 ± 1.24		Slower treatment of animal diseases	3.31 ± 1.08	
Benefits to your family	2.89 ± 1.21		Risks to you personally	3.30 ± 1.01	
Improved consumer health	2.87 ± 1.26		Risks to the environment	3.27 ± 1.02	
Benefits to you personally	2.87 ± 1.22		Risks to agriculture	3.23 ± 1.04	***
Improved human food quality	2.85 ± 1.29		Less professionally run farms	3.04 ± 1.10	
Increased consumer trust in food	2.83 ± 1.25		Less protection from predators	2.91 ± 1.09	
Reduced incidence of animal diseases	2.80 ± 1.28		Non-cost efficient production method	2.78 ± 1.11	
Improved nutritional quality of food	2.80 ± 1.28	***	Less protection from bad weather		
A natural production method	2.54 ± 1.34		More expensive food of animal origin		
Reduced animal stress	2.52 ± 1.32		Decreased availability of animal based foods		

*** = $p < 0.002$ Bonferroni adjusted p value, for Wilcoxon signed rank tests. Comparisons were made between each statement and the other statements, ranked by mean score.

<https://doi.org/10.1371/journal.pone.0210432.t004>

8 of the Top 10
about human
food or AW!





In Conclusion

...*There is no one conclusion*

REQUIRES MORE RESEARCH

- Correlation ≠ Causation
- Clear interconnecting factors but have current government requirements and HACCP principles made the worry for these obsolete?
- What more can we learn?



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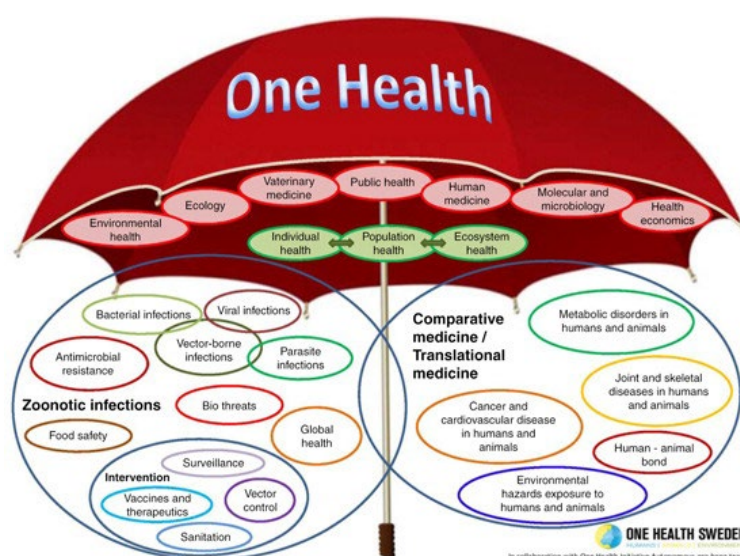
Project C: Blog Article – Animal Welfare and Food Safety: A One Health Approach

Animal Welfare and Food Safety: A One Health Approach

Food quality, food fraud, food safety, and animal welfare. Four well-known terms in our industries, but how do you judge one against the other? Do you sacrifice food quality for the sake of food quality? Do you allow food fraud to take place to enhance animal welfare? What is the cost when we think of these terms in such black and white terms and not as related and maintaining equality and equity. Another term that is less well known: One Health.

For those not already familiar with the concept, One Health is “an integrated, unifying approach to balance and optimize the health of people, animals and the environment.” (OHHLEP One Health definition, 2021) In other words, animals, people, and the environment are all related and we can no longer think of each as separate silos.

One Health can be thought of as an interconnected circle, a Ven Diagram, or even as an umbrella that covers all of the individual parts and modalities and shows some of the relationships, such as this graphic by One Health Sweden.



Included under this umbrella, amidst a plethora of other fields, lie those that are clearly connected to animals including Veterinary medicine, the human-animal bond, zoonotic infections, among others. However, if we look at it again, what else do we see? Public Health, human medicine, microbiology, environmental hazards to humans and animals, antimicrobial infections, vaccines—the list goes on and on. Past what is in this infographic.

If we think about the effect that animal welfare and animal health have on food safety, we need to use this same type of thinking. Just as we have done with food quality and studied the direct outcomes, such as PSE (pale soft and exudative) pork meat and dark cutters in cattle, so we can do in food safety outcomes due to improper handling events. However, to understand the true cost and effects, a holistic viewpoint and approach is required.

Starting to break down some of the interactions, we can think of three obvious food safety concerns from animals and animal products: pathogens, prions, and drug residues. For these Big 3, there are already established food safety plans and protocols in place to prevent contamination at the processing facilities (and the farm, in the case of medication withdrawal periods to combat drug residues). How then, are these combatted at the farm and during the live side of handling at the processing facilities?

Segregation of fit animals, hide washes, voluntary segregation of unfit animals, and ante-mortem inspection are a few of the ways that processing plants today minimize food safety risks within their control. How then, are farms minimizing risks? Medications are frequently used on-farm as part of routine care, and each of these has its own withdrawal period to ensure product safety. Biosecurity measures are also in place to work to prevent animal and zoonotic diseases. However, in both areas one common factor is often overlooked. What is it? Stress.

Stress has been known to cause food quality issues for years, but it is not often looked at in terms of the actual safety of the products. However, according to studies, an animal's response to stress is the primary method that poor welfare leads to poor health and then to food safety problems. This can be in a variety of methods, but stress can lead to decreased immune function and increased fecal shedding of pathogens such as *Salmonella enterica*, *E. coli* O157:H7, and *S. enteritidis*. This can cause greater likelihood of contamination at the processing facilities as well.

While more research is needed to prove the extent of the relationship between stress, animal welfare, and food safety, the consumers already have their idea of how intensive farming aka factory farming impacts the safety of our food. In short, they don't trust us.

"Despite... having some of the most stringent animal health and welfare regulations globally, most groups of stakeholders were not trusted by respondents to provide reliable information about these systems, with respondents distrusting most supply chain stakeholders." (Clark, B. et al., 2019)

This is shown directly in another study that asked the public their general perceived benefits and perceived risks of “factory farming.” The results showed that 8 of the top 10 perceived risks were around animal welfare and food safety. These included risks such as increased animal stress and disease, decreased animal welfare monitoring, reduced human food quality and safety, decreased consumer trust in food, reduced nutritional quality, and overall negative effects on consumer health. If we look a little further down the list, still in the top 15 include public health concerns such as risks to the consumers, to your family, and risks to your personally.

Perceived as a benefit			Perceived as a risk		
More cost-efficient production method	3.66 ± 1.07		Increased animal stress	3.88 ± 1.10	
Cheaper food of animal origin	3.65 ± 1.05		An unnatural production method	3.78 ± 1.10	***
Increased availability of animal based products	3.56 ± 1.03		Increased incidence of animal diseases	3.61 ± 1.08	
Greater protection from predators	3.42 ± 1.09		Reduced human food quality	3.56 ± 1.07	
Greater protection from bad weather	3.41 ± 1.09	***	Compromised FAW monitoring	3.55 ± 1.06	
Benefits to agriculture	3.18 ± 1.14		Decreased consumer trust in food	3.51 ± 1.09	
More professionally run farms	3.12 ± 1.17		Reduced nutritional quality of food	3.50 ± 1.07	
Faster treatment of animal diseases	3.10 ± 1.20		Reduced human food safety	3.46 ± 1.08	
Benefits to consumers	3.07 ± 1.17		Negative effects on consumer health	3.42 ± 1.08	
Improved FAW monitoring	3.00 ± 1.25		An unsustainable approach to animal production	3.40 ± 1.05	
Improved human food safety	2.99 ± 1.25		Risks to consumers	3.34 ± 1.10	
Benefits to the environment	2.96 ± 1.17		Risks to your family	3.33 ± 1.11	
A more sustainable approach to animal production	2.89 ± 1.24		Slower treatment of animal diseases	3.31 ± 1.08	
Benefits to your family	2.89 ± 1.21		Risks to you personally	3.30 ± 1.01	
Improved consumer health	2.87 ± 1.26		Risks to the environment	3.27 ± 1.02	
Benefits to you personally	2.87 ± 1.22		Risks to agriculture	3.23 ± 1.04	***
Improved human food quality	2.85 ± 1.29		Less professionally run farms	3.04 ± 1.10	
Increased consumer trust in food	2.83 ± 1.25		Less protection from predators	2.91 ± 1.09	
Reduced incidence of animal diseases	2.80 ± 1.28		Non-cost efficient production method	2.78 ± 1.11	
Improved nutritional quality of food	2.80 ± 1.28	***	Less protection from bad weather	2.78 ± 1.10	
A natural production method	2.54 ± 1.34		More expensive food of animal origin	2.75 ± 1.12	
Reduced animal stress	2.52 ± 1.32		Decreased availability of animal based foods	2.72 ± 1.08	

*** = p<0.002 Bonferroni adjusted p value, for Wilcoxon signed rank tests. Comparisons were made between each statement and the subsequent statement when ranked by mean score.

<https://doi.org/10.1371/journal.pone.0210432.t004>

(Clark, B. et al., 2019)

These are some hard-hitting statistics, but who can blame them? When consumers are more removed from their food than ever before, and with the power of social media and sad

commercials with Sarah McLachlan music, consumers are influenced by those with ulterior motives and large budgets. However, as an industry, we must recognize our faults. Part of that includes shutting the doors and not letting the public see how their food is produced. To show them all the good things that the industry is doing so they are not only bombarded with the twisted (and often downright false) negative narrative.

Taking a One Health stance and approach to this includes taking a good hard look at our industry. To start, what we can improve and how we can get the messages of the benefits of animal agriculture to the public? While we don't necessarily have the endless budgets from public donations that many Non-Governmental Organization (NGOs) have, we can start by inviting and encouraging those from multiple industries to all have a seat at the table. This multidisciplinary approach may just be what we need to not only change the conversation, but to continue to improve animal welfare, public health, and food safety.

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Project D – Standardized Bison Harvest Audit Tool

Bison Plant Audit

Date:		Location ID:		# Animals Processed/Hour:		Possible Points:	
Auditor:		Country:		# Trucks Observed:		Points Scored:	
Plant Contact:		State:		Weather:		Score %:	
						Result:	

Issue Date: January 31, 2023

Revision Date: NA

Revision #:0

Document Name: Audit-BisonPlant

Critical Failure *Any abuse of animals is a major non-conformance and an audit failure. Major non-conformances must be recorded and corrective actions made in all circumstances including retraining of all employees.		Pass / Fail	COMMENTS			
1	NO willful acts of abuse observed during the audit					
2	Are animals euthanized in a timely manner?					
3	If euthanasia is observed, are animals handled humanely during the process?					
4	If euthanasia is observed, do caretakers confirm insensibility and death after the euthanasia method is applied and before being removed from the facility?					
5	Zero sensibility is observed on the bleed rail.					
6	Animals have access to clean drinking water in holding pens.					
Animal Handling		Points	Yes / No	N/A	Points Scored	COMMENTS
7	Are animals handled properly for their age?	10				
8	Is proper handling equipment available and in good working order with no sharp edges?	10				
9	Can animal caretakers articulate or demonstrate appropriate equipment use during animal handling?	20				
10	Electric prods are used on 25% or less of animals in the lead up chute?	10				
11	Do 90% of the holding pens have adequate space allowance?	10				
12	Do 1% or less of the bison fall during handling?	10				
13	Do 3% or less of the bison slip during handling?	5				
14	Do 1% or less bison vocalize during handling?	10				
15	Are 99% of bison stunned adequately and appropriately?	25				
16	Do 40% or less crash into knock box?	5				
17	Do 25% or less crash into the knock box 2 or more times?	5				
18	2% or less animals observed have obvious, fresh injuries?	10				
Animal Handling - Section Points Total		130			0	
Training and Management Commitment		Points	Yes / No	N/A	Points Scored	COMMENTS
19	Management commitment is evident. (Committee involvement, trainings, etc.)	10				
20	Are handlers able to articulate and/or demonstrate the training they received specific to their daily duties, including handling and animal welfare?	10				
21	Are the handlers responsible for euthanasia able to articulate the site's euthanasia plan?	10				
22	If euthanasia is observed, are handlers following the site's SOP for euthanasia? N/A if euthanasia is not observed during the audit.	10				
23	Can handlers articulate the site's zero tolerance policy for willful acts of abuse and how to report abuse?	10				
25	Are handlers able to articulate and/or demonstrate the training they received specific to handling non-ambulatory bison?	10				
26	Does the facility train its personnel and have a written procedure or protocol about how to handle a sensible animal on the bleed rail?	10				
27	Does the facility provide special training to stunner operators to ensure proper equipment use and stunning efficacy?	10				
28	Are crowd pens less than 50% full?	10				
30	Are non-electrical devices the primary tool used to move livestock?	10				
Caretaker - Section Points Total		90			0	

Facility/Tools		Points	Yes / No	N/A	Points Scored	COMMENTS
31	The stunning/euthanasia equipment has sufficient power for the size of the animal, is in good working condition, and is readily available.	10				
32	Backup stunning/euthasia method is immediately available.	10				
33	Facilities are inspected at least weekly and documentation available of these inspections and maintenance requests for any damage or potential injury or escape points?	10				
34	Does the facility have a documented maintenance program for all stunning and euthanasia equipment?	10				
35	Is the penning appropriate and in a good state of repair and not causing or posing an imminent threat of injury to the animal?	10				
36	Is the flooring appropriate, non-slip, and in a good state of repair and not causing or posing an imminent threat of injury to the animal?	10				
37	Are the unloading ramps in a good state of repair and not causing or posing an imminent threat of injury to the animal?	10				
38	Are the alleyways in a good state of repair and not causing or posing an imminent threat of injury to the animal?	10				
Facility - Section Total		70			0	
Records/Plans		Points	Yes / No	N/A	Points Scored	COMMENTS
39	Does the facility train its personnel and have a written procedure or protocol about how to handle a sensible animal on the bleed rail?	10				
40	Does the site have a written stunning and euthanasia plan that is consistent with the current AASV or equivalent guidelines and is accessible to all handlers in the facility?	10				
41	Does the site have 12 months of records demonstrating routine maintenance and cleaning of stunning equipment?	5				
42	Does the facility have a documented training program for its employees or use an outside training program to teach the principles of good animal handling?	5				
43	Does the site have documentation of handler training specific animal handling, welfare, and all of their daily duties? (At a minimum, one time per year)	10				
44	Does the site have a well-known and publicly posted animal welfare policy and mechanism for reporting acts of abuse that allows anonymous reporting without the threat of retaliation?	10				
45	Does the site have 12 months of records demonstrating routine maintenance of euthanasia equipment? (If different from stunning equipment)	10				
46	Does the site conduct internal site assessments/audits of the facility, animals, caregivers, and all handling procedures at least weekly?	10				
47	Does the farm have a written zero tolerance policy for willful acts of abuse?	10				
48	Does the site have a written SOP for animal handling procedures?	5				
49	Does the company have an emergency management plan for livestock that includes how to provide food and water?	5				
50	Does the company have an emergency management plan for livestock in transit?	5				
51	Can management articulate these emergency plans?	5				
Records - Section Total		100			0	
Transportation		Points	Yes / No	N/A	Points Scored	COMMENTS
52	Number of compromised bison = 1% or less of load	10				
53	Are electric prods used as the primary tool for animal movement?	10				
54	If electric prods are used, are they being applied correctly? Note, if electric prods are being intentionally applied to sensitive parts of the body or used aggressively, this is an automatic audit failure.	10				
55	Do bison on the trailer show signs of overcrowding?	10				
56	Do 1% or less of bison fall during unloading?	10				
57	Do 10% or less of the bison being moved receive an electric shock?	10				
58	Is the trailer in a good state of repair?	10				
59	Is the trailer properly aligned with the loading/unloading area?	10				
60	Are transporters trained with industry standard training or plant-specific guidelines including animal handling and transport?	10				
61	Are handling tools being used correctly?	10				
62	Is the trailer appropriately equipped for weather conditions and phase of production during transport?	10				
Transportation/Load-Out - Section Total		110			0	
Total Points		500			0	
General Comments						