Livestock Mortality Composting to Mitigate Livestock Predator Interactions

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ABSTRACT: When a large animal dies on a farm or ranch, there are often few options for disposal. In California, there are limited legal options especially as rendering facilities have closed, and both regulatory burden and the number of predators on the landscape have increased. Livestock Mortality Composting could be a viable solution to address these challenges. Composting of mammalian tissue is legal in most states and recommended for on-farm disposal of livestock mortalities but is currently illegal in California. Instead, many ranches have opted to use "bone piles" to dispose of livestock mortalities. This option has been shown to attract large predators such as wolves, mountain lions, bears and others making it a hazard for livestock operations by increasing the likelihood of livestock-predator interactions. Removing these bone piles is the number one predator attractant removal recommended by Oregon Department of Fish and Wildlife. Mammalian tissue composting is also a viable option for waste from on-farm animal processing especially as this practice has become more popular in the last few years. After navigating the regulatory oversight of multiple local and state agencies, a livestock mortality composting site was approved for research at the Intermountain Research and Extension Center in Tulelake, California. This site has composted four adult cows and demonstrated the effectiveness and safety of this process. Pile temperature was taken at 18 and 36 inches from August 2020 to January 2022. After each additional mortality, the temperature reached over 131°F for at least 72 hours to kill potential pathogens. Trail cameras were deployed at the compost site and at three nearby bone piles to compare wildlife interactions. The bone piles received on average 390 and 292 visits from predators in year one and year two respectively compared to eight visits to the compost pile. A best management practices document has been written to provide an on-farm livestock mortality composting exemption that falls within current California composting laws. This exemption could be carried out at the local, regional, or state level, although permanent changes to this policy will most likely need a legislative change.

KEY WORDS: attractant removal, compost, human-wildlife conflict, livestock, mortality, predators

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INTRODUCTION

Disposal of livestock mortalities is a necessary piece of operation management. Mortalities are part of the typical 10-20% replacement rate for beef cattle operations (George et al. 2001). Regulatory complexity in California in combination with a lack of carcass disposal infrastructure in most areas of the state has resulted in an extremely burdensome process for those seeking to dispose of a livestock mortality. In addition to state and regional regulations, each county in California has unique restrictions on where carcasses can be buried (i.e., distance from waterways, ground water etc.). Therefore, carcasses are often either left to decompose "naturally" or moved to a carcass disposal pit (e.g., bone pile). Both options can lead to unwanted livestock-predator interactions as bone piles can be a food source for predators, effectively "drawing" predators to the ranch to feed. According to the Oregon Department of Fish and Wildlife, eliminating bone piles is the best way to reduce attractants to reduce wolf and other predation on livestock (ODFW 2021). Increased exposure to sunlight and oxygen also increases the time needed for decomposition of a mortality, resulting in bone piles and attractants with long life spans.

Livestock mortality composting is currently legal in all states except California. In California, livestock mortality composting is only accepted via executive order from the Secretary of Agriculture under emergency situations (e.g., extreme heat) where many animals have died at one time. Currently there are two legal options for livestock mortality disposal in California, which are dependent upon county regulation: 1) selective burial at depths deeper than 6 feet, and 2) disposal at a rendering facility or landfill that accepts mammalian carcasses. There are very few rendering facilities available in California and only one in the northern third of the state. For those that transport a carcass from a farm to a rendering facility, a dead animal hauler license is required. There is a fee to render a livestock mortality as well as a fee for transportation and a yearly fee for the dead animal hauler license. These limitations make hauling carcasses to a rendering facility unfeasible for most producers, particularly those in the far northern counties of California.

There were three objectives to this study. Objective 1: Determine the feasibility of composting of livestock carcasses (natural mortalities) and bone while integrating whether compost piles are an attractant to wildlife or other pest species; and compare frequency of visitation by scavengers and predators between compost piles with traditional bone piles and develop an outline for the process, capacity, timeframe and nutrient profile of livestock carcass composting. Objective 2: establish an economic model for composting procedures and benefits (pending legalization of composting in California). Objective 3: extend results to livestock producers, UC Cooperative Extension Advisors, regulatory agencies, and others; and use research findings to develop policy guidelines for the appropriate use of carcass composting.

METHODS

A compost site was chosen at the Intermountain Research and Extension Center in Tulelake, California. Letters and permits were submitted to agency staff from Siskiyou County Environmental Health, CalRecycle, California Department of Food and Agriculture (CDFA), CA State Veterinarian, and the regional and state water board to obtain a research exemption for a livestock mortality composting site. The permitting process took a year, from June 2019 to July 2020, for approval.

An existing 3-sided structure with cement at the base was retrofitted to accommodate the permitting regulations for the composting pile. A metal- roofed carport structure was installed within the structure as a roof, required by the regional water quality board to be considered an enclosed vessel. Base rock material was placed on the floor and a pond liner was put on top of the rock to act as an impermeable layer. Another layer of base rock was added on top of the pond liner. Then tube sand was used to secure the pond liner and created a basin to deter any runoff from the site. A berm was placed at the front of the structure to deter any runoff, however it allowed access for management of the pile (i.e., adding carcasses, rotating the pile, etc.).

On August 10, 2020, the first cow was identified for the compost pile. Livestock mortalities that have only died of natural causes are allowed to be composted to prevent pathogen spreading. Recommendations provided by the United States Department of Agriculture (USDA 2017) were used to build the compost pile as demonstrated in Figure 1. Once the cow arrived at the composting site, the rumen was punctured to prevent bloating and a layered base of fine and coarse wood chips and straw was laid out approximately 18-24 inches deep as an absorptive layer on top of the base rock. The carcass was placed in the center of the structure on top of the layered base materials. Once the carcass was positioned, carbon materials of straw and wood chips were layered on top. Materials were by-products from the Alturas, CA lumber mill. A sprinkler was available to add moisture as needed during the study.

Temperature readings were taken daily at 18 and 36 inches, moisture readings taken once per week, and pH samples are taken once per month. A temperature of 131°F was maintained for at least 72 hours, as that is the minimum requirement to kill potential pathogens in the compost pile (USDA 2017). Water was applied as needed after each pile rotation and by determining compost moisture using the squeeze method (Rozeboom et al. 2013), and extra wood chips and straw were available as the pile shifted and needed extra material.

On November 17, 2020, the pile was rotated for the first time according to composting recommendations to rotate roughly every three months. At this time, a compost sample was taken and sent to Denele Analytical, Inc. (Turlock, CA) and a complete manure compost analysis was done. New livestock mortalities were added for composting on January 12, June 12, and June 29, 2021. This process differs slightly from initial compost pile creation. The pile is opened, with the new mortality set into the center of the pile, and a combination of new and old materials were placed on top, resulting in some rotation of the compost material as well as the addition of new material. The pile was rotated using a backhoe and hand rake, and several samples were taken to compose one sample for analysis on May 20, 2021, September 20, 2021, and December 13, 2021.

In January 2022, 16 months after beginning the compost project, it was determined that the compost had cured, and little active composting was taking place. The pile was sifted through a handmade structure to remove any large bones and clumps of bulking material and a sample was taken for analysis. Few bones and bulking material remained, and a new compost pile was made to

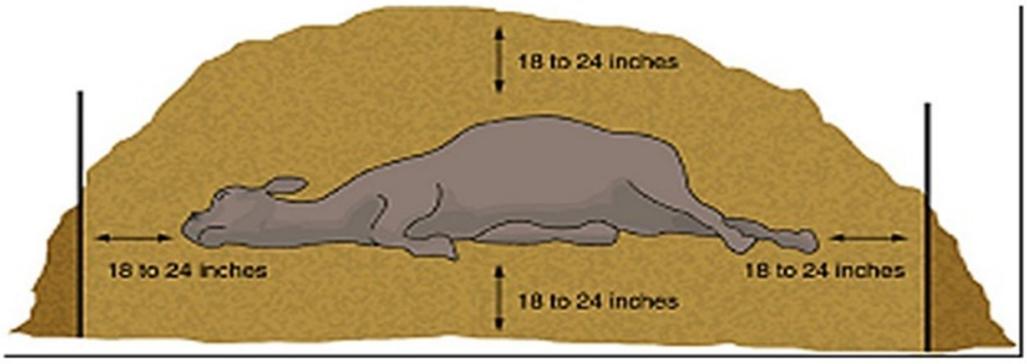

Figure 1. Recommendations provided by United States Department of Agriculture: how to build a compost pile.

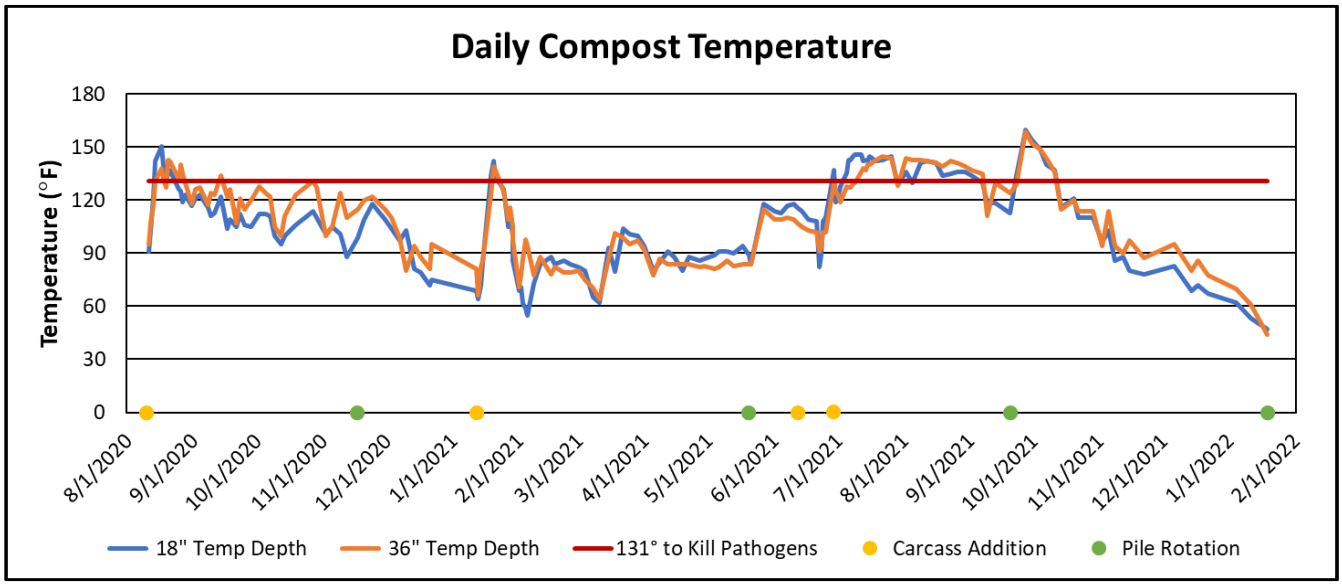

Figure 2. Daily compost temperatures at 18 and 36 inches from August 2020 to January 2022.

continue the composting process. Pitting was evident on all the bones, a sign that composting was taking place, although bones take longer to decompose than soft material.

Trail Cameras

Two trail cameras were installed per location at bone pile sites A and B. Bone pile site C had one trail camera installed. The cameras were placed pointing in different directions where most of the carcasses were placed. The height of the cameras was approximately 3-4 ft off the ground, depending on the location and closeness to the disposal site. The cooperating producers were asked to place new mortalities in the areas where our cameras were facing. The settings on the cameras were to capture two photos per activation, full screen with high resolution. We experimented with 10-second and 30-second intervals for activation times. The 10-second interval was too quick in windy areas, where we picked up a lot of grass and tree branch movement. The 30-second interval seemed to be the best in these locations. The camera data was downloaded once every three months. One camera was placed at the compost site pointing directly at the pile at a height of 3.5 feet off the ground. The camera settings interval at this site was 10 seconds. The data was downloaded once every three months at this location.

RESULTS

This project successfully composted four cattle carcasses at the Intermountain Research and Extension Center from August 2020 to January 2022. The required 131°F temperature was achieved for a minimum of 72 hours, to kill pathogens as outlined by USDA, after each additional mortality. Troubleshooting of composting challenges such as limited moisture, limited available nitrogen, and finding easily sourced carbon materials was completed. Predator interactions at the compost pile versus several bone piles were monitored by trail cameras and found significantly fewer interactions at the compost pile.

Temperature

Temperature ranged from 44°F at the end of our study period to 159°F after the pile was rotated in September 2021. Active composting can occur at all temperatures observed in the study, although temperatures above 68° exhibit higher rates of decomposition (USDA 2017). Figure 2 shows the daily compost temperature at 18 and 36 inches, from August 2020 to January 2022. Along the bottom of the figure, dates where carcasses were added, and pile rotation occurred, are noted. The 131°F threshold for pathogen destruction is also present as a solid line for reference. After each additional carcass and each pile rotation, the temperature spikes as bacterial activity also increases. This is a sign of proper compost management.

Nutrients

Nutrient samples were taken four times throughout the project and presented in Table 1.

Trail Cameras

A variety of small and large predators frequented bone piles in Siskiyou County. “Birds of prey” included eagles, crows, hawks, and turkey vultures. “Small scavengers” included bobcat, skunk, raccoon, porcupine, and fox. Site B did have one visit from a mountain lion which is not captured in the data. In year one, visits to bone piles ranged from 120 at site C to 727 at site A; site B had 324 visits. In year two, site B had 370 visits and site C had 214 visits. Although this is a small sample size, that is an average of 390 visits per site in year one and 292 visits in year two. The compost pile was monitored utilizing a trail camera during year two and resulted in eight visits for the year, seven small scavengers and one coyote. Results can be seen in Figure 3.

There are many factors that could contribute to trail camera numbers including proximity to forested areas,

Table 1. Nutrient results from samples collected throughout duration of the project.

Compost Nutrient Analysis	Units	Sample Date			
		11/19/2020	5/24/2021	9/28/2021	1/21/2022
Moisture (H_2O)	%	62.1	39.3	51.6	45.8
pH	N/A	5.8	5.1	6.4	5.1
Electrical Conductivity (EC)	mmhos/cm	1.19	6.27	2.32	7.54
Boron (B)	mg/L	0	3.27	6.67	20.75
Zinc (Zn)	mg/L	558	293	141	387
Iron (Fe)	mg/L	12200	10900	12000	11060
Manganese (Mn)	mg/L	163	201	156	199
Copper (Cu)	mg/L	30.7	46.9	23.9	36.35
Organic Matter (OM)	%	46.4	51.6	60.3	54.7
Potassium (K)	%	0.356	0.453	0.235	0.363
Total Phosphorus (TP)	%	0.11	0.106	0.103	0.147
Sodium (Na)	%	0.067	0.162	0.114	0.163
Calcium (Ca)	%	1.25	0.96	0.631	0.8395
Magnesium (Mg)	%	0.435	0.429	0.414	0.402
Sulfur (S)	%	0.09	0.12	0.07	0.13
Total Nitrogen (TN)	%	0.311	0.71	0.78	0.819
Soluble Salts (SALT-SOL)	mg/L	762	4010	1480	4825
Carbon:Nitrogen Ratio (C:N)	N/A	85:01:00	42:01:00	44.1	38.1

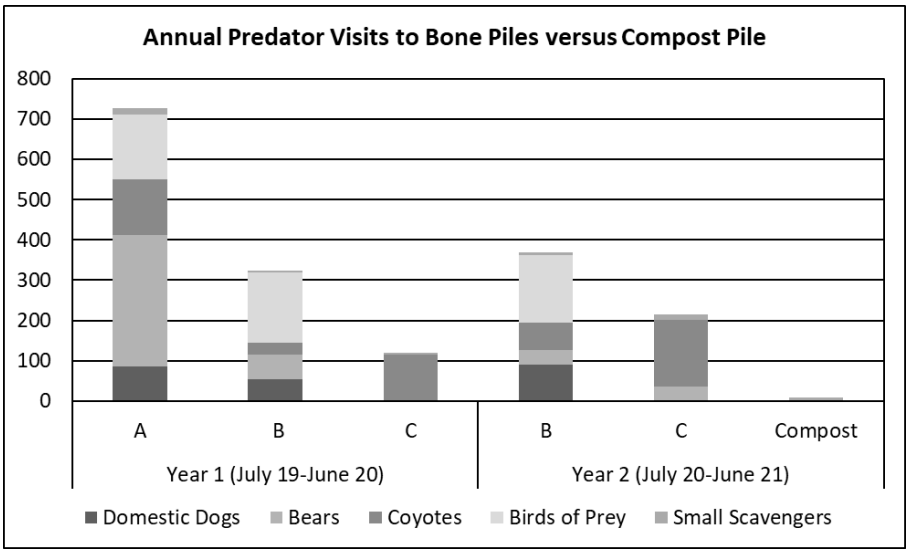

Figure 3. Annual predator and scavenger visits to bone piles (sites A, B, & C) versus compost pile.

urban populations, human presence, etc. that prevent detailed analysis and conclusions. The data itself varies immensely from site to site, but in the bigger picture, all trail cameras were placed in a relatively rural area, near agricultural fields, and known to be available to predators. A general conclusion can be made from this data that the compost pile seems to be a much lesser attractant to predators compared to bone piles. This supports recommendations by ODFW to remove bone piles as a worthwhile mechanism for attractant removal.

DISCUSSION

This demonstration study, as well as countless others across the United States (Bonhotal et al. 2010, USDA 2017), have demonstrated that on-farm composting is an effective, environmentally friendly, and economically viable alternative to current carcass disposal options and could be a viable tool for ranchers to reduce livestock-predator interactions. This is of particular importance in California, which has special protections for many species, including the grey wolf (*Canis lupus*), mountain lion (*Puma concolor*), and black bear (*Ursus americanus*).

Composting can be implemented using materials and equipment that is readily available on farms and ranches, making the process self-sustaining and economical (Bonhotal et al. 2010). The composting process is relatively quick. It takes approximately one year for the carcass of a mature cow to be fully composted and most of the soft tissue and bones are decomposed by 6 months. To compost one carcass, it would take approximately 10 cubic yards of carbon-rich "starter" material, such as wood chips or used livestock bedding. The end product is cured compost which then can be applied back to the ranch as a value-added product to increase soil organic matter.

Over the last several years, California has passed several bills to divert organic waste from landfills to compost operations. Although falling short of allowing livestock mortality composting, these bills may provide a window for regulatory change. SB1383 was passed in 2016 and implemented August 1, 2022, with the goal of reducing methane emissions and short-lived climate pollutants in California. Historically, organic waste such as food scraps, yard trimmings, paper, and cardboard ended up in the landfills, much like livestock mortalities in climate emergency situations. This organic waste accounted for half of what is dumped in landfills and contributed significant emissions of methane into the atmosphere.

Using this bill and resulting guidelines, composting of on-farm mortalities could be classified in statute 178555. "Excluded Activities (a) # 1 activity excluded if it handles agricultural materials, derived from an agricultural site owned or leased by the owner. No more than 1,000 cubic yards of compost product may be given away or sold annually" (DRRR 2022).

The next steps in this study are to continue producer and agency outreach as well as continue the livestock mortality composting research as a demonstration site. A best management practices document has been written using research from this study and other livestock composting studies to aid policy makers in envisioning how to implement this process in California within the current policy language.

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