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INTRODUCTION

Potential transmission of bovine brucellosis (*Brucella abortus*) from wild elk and bison to cattle affects the viability of cow-calf operations in northwest Wyoming. Between 2004 and 2014, nine cattle herds and one domestic bison herd in Wyoming contracted the disease, along with nine cattle herds and two domestic bison herds in Montana and Idaho. In response to this series of outbreaks, producers are experimenting with a growing set of management tools to reduce their herds' risk of contracting brucellosis.

Spaying heifers is one tool with some potential to help reduce brucellosis risk. Although spayed heifers can still contract brucellosis from licking or sniffing contaminated material (such as placenta or aborted fetuses from an infected animal), they cannot spread the disease because they are not reproductively intact. Spayed heifers are therefore not tested for brucellosis (USDA, 2003). This is most relevant to a producer when their herd is under quarantine for brucellosis. In this situation, all reproductively-intact heifers within that herd must be quarantined and tested multiple times, regardless of their age. This is true also for any herds that commingled with the infected herd. Spayed heifers, on the other hand, do not have to be quarantined or tested (Logan, 2015). They can be moved to pasture or sold, as usual, without any costly delays. (Side-note: steers and bulls are also exempt from brucellosis testing and quarantine.)

The motivation to spay heifers is less clear for herds not under quarantine for brucellosis. In this more typical situation, Wyoming Livestock Board rules actually allow reproductively-intact heifers to be sold and moved outside the DSA without brucellosis testing, but only if two conditions are met: (1) the heifers are less than 18-months old, and (2) they are being sold for feeding purposes only, not for breeding (Winslow, 2015). In contrast, older heifers – those 18 months or older – that originate from the DSA must be tested for brucellosis before they are sold or moved outside the DSA, regardless of their intended purpose (feeding or breeding), unless they are spayed. For producers worried about their herd contracting brucellosis or being exposed through commingling, spaying heifers clearly helps reduce the risk and financial consequences of being quarantined.

Spaying offers other benefits as well, such as prevention and early detection of unwanted pregnancy in young heifers (Weddle-Schott and Meyer 2008). A producer can expect as many as one-third of all heifers to become pregnant during the summer grazing months in areas with limited control of bulls, such as common grazing allotments or pastures that share a fenceline with bulls (Lucas, 2010). Heifers that end up calving in a feedlot cost operators upwards of $150 to $200 per head, due to complications or decreased weight gain (Weddle-Schott and Meyer, 2008). Feedlots obviously prefer spayed heifers, yet there is no evidence they offer a premium for them (Carman, 2010).

SPECIAL COSTS TO CONSIDER

The economic feasibility of spaying heifers as a brucellosis management practice depends not only on the benefits it generates, but also the costs. One subtle, yet important, cost of spaying heifers is that it limits a producer's options for marketing those heifers. In recent years, heifers have been more valuable as breeding livestock than as feeders, so spaying could impose a high opportunity cost.

There are also physical risks involved with spaying. In the past, spaying was performed by removing a heifer's ovaries through an incision in her flank. Depending on a veterinarian's experience with this procedure, it could be time-consuming and expensive. Flank spaying also occasionally causes infections at the incision site, which may interfere with the hide-pulling process at harvest, resulting in excess carcass trimming.

Today, spaying is often performed vaginally using tools such as the Willis or Kimberling-Rupp instruments, a procedure that some believe is less time-consuming and risky (Garber et al., 1990; Lucas, 2010). This depends, however, on the ability to find a veterinarian with extensive experience conducting vaginal-ovariectomy, who is also available when needed. Even with a skilled veterinarian, some risks are involved, including incomplete ovary detachment, pelvic inflammatory disease, and death of the heifer (Cain, 2012). Veterinary and labor costs associated with this approach to spaying are quantified in the table below.

An important part of the cost of spaying is the potential for a heifer to die as a result of the vaginal spaying procedure. Spaying has become safer over the years, but an experienced veterinarian can still expect to lose 8 out of every 20,000 heifers to excessive blood loss (Lucas, 2010). An additional 1 out of every 20,000 heifers is lost to accidental severing of an intestine during the spaying procedure. This error is often caught and repaired before extensive damage occurs, but not always. Overall, then, a producer can expect to lose 9 out of every 20,000 heifers during the spaying procedure to these two sources of medical risk (Lucas, 2010). The average (or expected) cost of death loss as a result of spaying can be calculated by multiplying the probability of losing a heifer due to spaying (9 ÷20,000 = 0.00045, or 0.045 percent) by the value of the heifer lost, and by the number of heifers spayed.

Another cost of spaying is the reduced productivity of spayed heifers, unless they are given implants. In one experiment, non-implanted spayed heifers averaged 2.1 pounds of daily gain in the feedlot, whereas non-implanted intact heifers averaged 2.4 lbs. of daily gain (Garber et al., 1990). In contrast, spayed heifers implanted with Synovex H averaged 2.8 lbs. of daily gain (a 0.7 lb. increase), whereas intact heifers implanted with Synovex H averaged 2.6 lbs. of daily gain (a 0.2 lb. increase) (Garber et al., 1990). The experiment demonstrated that spayed heifers' diminished weight gain in the feedlot, compared to intact heifers, could be recovered (and then some) by implanting them with Synovex H. Heifers today are typically implanted with Synovex H, Revalor G, or Synovex IH (Paisley, 2010).

Whether these weight gains would be the same in a rangeland setting, or whether a feedlot would prefer a heavier spayed heifer to a lighter one, is unclear. Here, we assume the producer implants heifers after spaying (at a cost of $3.44 per dose) to maintain or enhance daily weight gain. We do not attempt to determine whether the benefits of implanting spayed heifers actually outweigh the costs. A producer should explore this question further before deciding whether implants make economic sense for their individual operation. The cost of implanting is included in the spaying budget below in case a producer decides to pursue this option.

DETAILED COSTS AND ASSUMPTIONS

Table 1 summarizes the estimated costs of spaying heifers on a representative cow-calf-yearling operation in western Wyoming. This hypothetical ranch consists of 400 bred cattle (368 of which will calve in any given spring), 80 replacement heifers chosen from the current calf crop, and 100 heifer calves that will be spayed as yearlings and sold as long-yearlings. Spaying costs include veterinary fees, labor costs, average death loss, implants, antibiotics, squeeze chute depreciation, and meals. All costs are based on prices from the year 2010, so readers should keep in mind some costs may have risen (or fallen) since then. Prices from 2010 are used so readers can

compare the cost of spaying with the cost of other brucellosis management tools described in this same bulletin series (B-1232).

We begin by assuming 100 heifers are run through the chute solely for spaying, not in conjunction with branding or vaccinating. The veterinarian charges $6.25 per head, not including mileage, lodging, and per diem (Lucas, 2010). A highly experienced veterinarian can spay as many as 70 to 80 head per hour, but we assume a more conservative estimate of 35 head per hour, or roughly 2 minutes per heifer (Lucas, 2010). Labor costs include the owner, hired worker, and temporary workers' time to gather and sort heifers, and assist with spaying. We assume it takes 4 hours to gather heifers and 1 hour to separate the 80 replacement heifers from the 100 heifers chosen for spaying. The group chosen for spaying should be held off feed for 24 to 48 hours before the procedure, and restricted from water for 24 hours before, to minimize medical complications and death loss (Winslow, 2015). The spaying procedure itself takes just under 3 hours for 100 heifers, including time to administer antibiotics and implants (Hewlett, 1993; Lucas, 2010). Wear-and-tear on a squeeze chute is roughly $2.76 per hour (assuming straight-line depreciation) for a cost of $8 for the entire spaying session (Seavert et al., 1992).

Risk of death loss is included in the cost estimate by assuming 9 out of 20,000 heifers, or 0.045 percent of heifers, will be lost as a result of the spaying procedure. The market value of a 700-pound yearling heifer on May 21, 2010, was approximately $109 per hundredweight (cwt), or $763 per head (Torrington Livestock Exchange, 2010). If 0.045 percent of 100 heifers die because of the spaying procedure, and each heifer is worth $763, then the risk of death loss is $34 per year [0.00045 x 100 head x $763 per head]. In most years, no heifers will die as a result of the spaying procedure and the actual death loss will be $0; however, one heifer out of every 2,222 that undergo spaying is expected to die (this is equivalent to 9 of every 20,000). Suppose a producer spays 100 heifers every year for 22 years. They would expect to lose one heifer during that period, on average. (Note: there is some probability they will lose more than one heifer.) So, if a producer sets aside $34 each year, then by the end of the 22nd year they will have roughly enough money saved up to 'pay' for the one heifer expected to die during that period. Of course, as cattle prices rise (or fall), the cost of losing a heifer will be larger (or smaller).

Veterinarians experienced in spaying heifers are not readily available in western Wyoming. They often travel into the area from as far away as Torrington, or western Nebraska. Compensation for the veterinarian's travel expenses, mileage, per diem, and lodging are therefore included in the analysis as an 'overhead fee.' The mileage rate was obtained from the Internal Revenue Service (2009), and the per diem and lodging rates were obtained from the United States General Services Administration (2010). These costs will vary, of course, depending on a veterinarian's distance and special pricing. Lastly, the ranch is assumed to provide one meal for the hired labor and veterinarian, at a cost of $50.

TOTAL COST VERSUS BENEFIT

The total cost of spaying 100 head of heifers is approximately $2,291 (assuming prices from the year 2010). A producer should spay heifers only if the benefits of doing so outweigh the costs. The benefit of spaying heifers is difficult to quantify because a herd's initial risk of contracting brucellosis (in the absence of spaying) is uncertain. What we do know for certain is spaying heifers will eliminate the need to test those animals for brucellosis when sold or moved outside the DSA. But the producer's female breeding stock are still at risk. This portion of the herd can still contract brucellosis and be placed under quarantine and testing.

At the very least, spaying heifers reduces the financial consequence of contracting brucellosis by reducing the proportion of a herd that must be quarantined when an infected animal is detected. Spayed heifers, like steers and bulls, are not subject to brucellosis testing and can therefore be moved to pasture or sent to market regardless of their herd's brucellosis status. This reduces the number of animals that require supplemental forage during a quarantine, which could save several thousands of dollars. Nonetheless, benefits are difficult to quantify and probably unique for each cattle operation, so we focus instead on providing a detailed cost estimate. Producers can

then weigh that cost against their subjective estimate of benefits.

For producers with more than 100 heifers (or fewer), itemized costs in Table 1 can be scaled up (or down) to reflect their unique herd size. Some costs will change proportionally with herd size, such as the cost of antibiotics and implants. Some costs may change less than proportionally with herd size, such as labor-hours to gather heifers. For example, it might take the same number of people and hours to gather 50 heifers from a large pasture as it takes to gather 100 or 200 heifers from that pasture. Some costs might not change at all with herd size, such as a veterinarian's overhead cost (mileage, lodging, per diem). A producer should consider their operation's unique characteristics – and how these could affect the logistics of spaying – when adjusting costs in Table 1.

Finally, the cost of spaying heifers will change whenever the price of inputs or value of heifers change. Costs in Table 1 are based on prices from the year 2010. This allows readers to compare the cost of spaying heifers to the cost of other brucellosis management activities reported in this same bulletin series (for example, fencing stackyards). Prices typically rise through time, though, so the cost of spaying and all other management activities have likely increased since 2010. Some prices remain the same, however, for several years (hired labor, for example), or even go down in the short-run (fuel prices, for example). If readers would like to update prices in this bulletin to current levels, they should adjust all prices, or at least prices for the items that make up the largest portion of the budget (the veterinarian's time, materials, mileage and overhead; antibiotics and implants; and temporary labor).

SUMMARY

This bulletin provides cow-calf-yearling producers with a detailed cost estimate for spaying yearling heifers using a vaginal procedure (rather than through the flank). The total cost of spaying 100 yearling heifers is $2,291, or approximately $23 per head, based on prices from the year 2010. Producers can manually adjust the cost estimates in Table 1 for their herd size and desired year of prices.

Costs should then be compared with their best estimate of the potential benefits of spaying (using a vaginal procedure) to decide whether it might be a beneficial management tool for an operation. Producers should also compare the net benefit (that is, benefits minus costs) of spaying heifers with the net benefit of other brucellosis management activities, such as fencing haystacks (see UW Extension bulletin B-1232), adult-booster vaccination, or perhaps sexed semen (to increase the ratio of steers in a yearling herd, so spaying is no longer relevant).

For producers in the Designated Surveillance Area of the Greater Yellowstone Ecosystem who believe their herd is at risk of contracting brucellosis, the benefits of spaying would generally include fewer test-eligible and quarantine-eligible animals in the event their breeding stock did become infected. But each herd faces a unique level of brucellosis risk, and unique consequences of quarantine depending on herd-size, timing of detection within the production calendar, availability of quarantine-eligible pasture, and cost of hay. Estimating the expected benefit of spaying for a 'representative' operation is difficult. Producers who would like to estimate the benefits and costs of spaying for their operation are encouraged to contact Associate Professor Dannele Peck at the University of Wyoming.

Contact the Wyoming Livestock Board for up-to-date information about the availability of cost-share programs for spaying heifers in areas of northwest Wyoming that face relatively higher levels of brucellosis risk.

Table 1. Annual cost of spaying 100 heifers (using prices from the year 2010).

Activity	Quantity	Unit	Cost (per unit)	Unit	Total cost
Gather heifers					
Owner labor	4	hours	$13.85	hour	$55
Hired labor	4	hours	$13.85	hour	$55
Temp labor (3 workers for 4 hours each)	12	hours	$13.85	hour	$166
Sort heifers					
Owner labor	1	hour	$13.85	hour	$14
Hired labor	1	hour	$13.85	hour	$14
Temp labor (3 workers for 1 hour each)	3	hour	$13.85	hour	$42
Spay heifers (35 head per hour)					
Spaying procedure (vet's time & materials)	100	head	$6.25	head	$625
Owner labor	2.86	hours	$13.85	hour	$40
Hired labor	2.86	hours	$13.85	hour	$40
Temp labor (3 workers for 2.86 hours each)	8.57	hours	$13.85	hour	$119
Antibiotics (LA-200)	100	doses	$3.13	dose	$313
Implants (e.g., Synovex H)	100	doses	$3.44	dose	$344
Squeeze chute depreciation	2.86	hours	$2.76	hour	$8
Average death loss (9 deaths per 20,000 head spayed = 0.00045 risk per head * 100 head spayed = 0.045 head lost, on average)[1,2]	0.045	head	$763	head	$34
Meal	1	meal	$50	meal	$50
Mileage, lodging and per diem for vet ($0.50/mile X 415 miles; 1 night lodging and per diem)	1	charge	$372	charge	$372
Total cost to producer[2]					$2,291[3]

[1] The loss of 0.045 head per 100 heifers spayed is physically impossible but should be interpreted as follows. Suppose a producer spays 100 heifers every year for the next 100 years. By the end of 100 years, they would expect to lose a total of 4.5 head. If the producer set aside $34 each year, they would have enough money set aside by the end of the 100th year to replace roughly 4.5 heifers lost during spaying (assuming a heifer is worth $763, or $109 per hundredweight for a 700-pound animal).

[2] If no heifers die during spaying, replace the $34 'average death loss' with $0; this will decrease 'total cost to producer' from $2,291 to $2,257. If one heifer dies during spaying, replace the $34 'average death loss' with $763; this will increase 'total cost to producer' from $2,291 to $3,054. Death during the spaying procedure is relatively unusual (only 9 deaths out of every 20,000 heifers spayed, or 0.00045 deaths per 1 heifer spayed); therefore, the 'expected' or 'average' cost of death loss in any given year is much closer to $0 than to $763. The cost of spaying increases quickly with each additional heifer death, which highlights the importance of hiring a qualified veterinarian with experience spaying heifers.

[3] This total cost does not account for any loss of daily weight gain due to spaying because we assume implants offset such losses (Lucas, 2010).

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