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Economics of Transitioning from a Cow-Calf-Yearling Operation to a Stocker Operation

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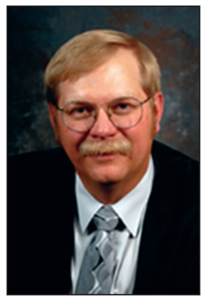
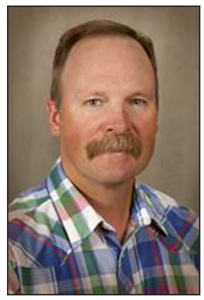
ABSTRACT

One alternative to a cow-calf-yearling operation is a stocker operation. Relative profitability of cow-calf-yearling versus stockers is well documented. Little is known, however, about the economics of the transition process itself. We analyze benefits, costs, and risks of switching from cow-calf-yearling to stockers over a one-year versus seven-year transition period. Results show a gradual transition is superior to an abrupt transition. A gradual transition to stockers generates more net present value than cow-calf-yearlings, given a sufficiently high discount rate or short planning horizon. Farm managers and consultants should include transition-period benefits and costs when analyzing alternative enterprises.

One alternative to a traditional cow-calf-yearling operation is a stocker operation, where weaned calves are purchased, and grazed as yearlings, before being marketed to a feedlot. Potential reasons to switch from cow-calf-yearlings to stockers-only might include a desire to avoid winter feeding, eliminate calving, adapt more quickly to forage availability, or reduce disease-risks associated with breeding cattle without exiting the livestock industry entirely.



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One disease that may prompt an interest in switching from cow-calf-yearlings to stockers is bovine brucellosis. *Brucella abortus* is an infectious bacterium that causes abortion in domestic and wild ungulates, as well as undulant fever in humans. Brucellosis is endemic in wild elk and bison in the Designated Surveillance Area (DSA) of the Greater Yellowstone Area (GYA). Cattle typically contract brucellosis by ingesting or inhaling infectious materials, such as placenta, reproductive fluids, or contaminated soil and forage, at a site where an infected animal aborted or gave birth (Schumaker, Peck, and Kauffman, 2012).

When a suspected case of brucellosis is detected in test-eligible cattle, the herd is quarantined and tested until all infected animals are found and culled. Any herds that have shared a fence-line or comingled with the "index" herd during the brucellosis risk-period are also quarantined and tested. This regulatory response can lead to large decreases in profits for affected producers, depending on the timing and length of quarantine, availability and cost of forage during quarantine, and number of animals culled (Wilson, 2012). Thus cattle producers in the GYA are searching for alternative management strategies to reduce the risk and economic consequences of brucellosis.

Because brucellosis is spread only by reproductively-intact cattle, the risk of quarantine can be eliminated by converting from cow-calf-yearlings to stockers only (steers or spayed heifers). Such a conversion would allow producers to remain engaged in the cattle industry, thereby preserving their lifestyle, instead of transitioning out of the industry entirely. Producers in the GYA have expressed concern, however, about the profitability and financial riskiness of stockers (personal communication, Wyoming Brucellosis Coordination Team, April 12, 2012). They have also expressed concern about liquidating breeding livestock within a single year. The objectives of our research are therefore to: (1) quantify the profitability and financial risk of a stocker operation, relative to a cow-calf-yearling operation typical of the GYA; and (2) compare the performance of a one-year versus seven-year transition from cow-calf-yearlings to stockers.

Roberts (2011) provides preliminary enterprise budgets for a cow-calf-yearling operation and a stocker operation representative of northwest Wyoming. His results suggest that stockers are less profitable, on average, than cow-calf-yearling. But his analysis does not consider the actual process of transitioning to a stocker operation, or the associated benefits and costs. Nor does he explore the variability of profit across years due to fluctuating prices. Anderson et al. (2004) found that stocker cattle in the southeastern US generate higher returns than leasing forage or grazing contracts, but those returns are more variable. Nader et al. (2010) indicated a profit potential for some stocker cattle systems in California, but not all. The narrow margin between purchase and sale prices (the buy-sell margin) is often a significant risk for stocker operations.

Ritten et al. (2010) found that adding a yearling enterprise to cow-calf operations – akin to a partial transition towards stockers – improves profitability and reduces income variability during periods of drought, compared to purchasing additional feed or weaning calves early. Similarly, Doye et al. (2013) concluded that producers can use stockers to improve cash flow and reduce debt requirements as they rebuild cow herds after drought-induced liquidations. Overall, the literature suggests that stocker enterprises may be profitable, but highly variable across production practices and years.

One detail often overlooked in the literature, and perhaps by farm managers and consultants as well, is that most studies compare two production systems as if they existed side-by-side, or could transform instantaneously from one to the other. Researchers rarely consider the economics of the transition process itself, which could generate additional benefits and costs that are relevant to decision-making. Our study's unique contribution is a detailed analysis of two different strategies for transitioning from a cow-calf-yearling operation to a stocker operation. The results can help cattle producers, ranch managers, farm consultants, extension educators, and policymakers better-understand the tradeoffs involved with transitioning from cow-calf-yearlings to stockers, either abruptly (within a single year) or gradually (over seven years).

Methods

Enterprise budgets

First, we develop enterprise budgets for a baseline cow-calf-yearling operation (see Ruff et al. 2014a), and a stand-alone stocker operation (see Ruff et al. 2014b). These budgets are an adaptation of Roberts (2011), augmented with information from a producer-group interview (Northwestern Wyoming Cattle Producers, 2013). Then we model the process of transitioning from cow-calf-yearlings to stockers under two different strategies: an abrupt one-year transition versus a gradual seven-year transition. For each transition strategy, we develop yearly budgets that capture changes in production activities, resource requirements, and associated revenues and costs. Example changes during the transition include: the number of cattle in different age-classes and types; spaying of all heifer calves transferred into the yearling operation; decreased labor requirements during calving season; and increased fence maintenance.

Cow-calf-yearling operation

The baseline cow-calf-yearling budget has, at its peak, 480 breeding animals and 280 yearlings. At the time of spring calving, there are 368 cows and 80 replacement heifers for a total of 448 breeding animals. The ranch produces 368 calves, but assuming a 2 percent death loss, this leaves 360 calves. All 180 steer calves are transferred to the yearling enterprise in mid-November along with 100 heifer calves. The remaining 80 heifer calves are retained in the cow-calf enterprise as replacement heifers.

Steer and heifer calves are transferred to the yearling enterprise at 550 pounds and 500 pounds, respectively. These incoming animals are fed hay throughout the winter and spring, grazed on rangeland during the summer, and fed for 10 days before being marketed in September as long-yearlings, at roughly 18 months of age.

To determine the number of head the operation can support on summer grazing, we use an "animal unit equivalent" (AUE). AUE is calculated using the metabolic weight (in pounds) of livestock (Manske, 1998). It provides a more accurate representation of livestock forage consumption than the standard animal unit (AU) calculation. AUE is calculated using the following equation:

$$(1)\quad \frac{(Live\ animal\ weight)^{0.75}}{1000^{0.75}} = Animal\ Unit\ Equivalent\ (AUE).$$

During summer grazing, there are: 235 adult cows (with calves), weighing 1200 pounds each, with an AUE of 1.147 per cow; 62 three-year-old cows (with calves), weighing 1200 pounds each, with an AUE of 1.147 per cow; 71 two-year-old cows (with calves), weighing 1000 pounds each, with an AUE of 1.0 per cow; and 80 replacement heifers, weighing 900 pounds each, with an AUE of 0.924 per heifer. All cow-calf pairs and replacement heifers require a total of 485.58 AUs for summer grazing.

For the yearling enterprise within the cow-calf-yearling operation, we assume steers go to grass at 700 pounds and weigh 977 pounds by the end of the grazing season, for an average grazing-season weight of 838.5 pounds. Heifers go to grass at 650 pounds and weigh 927 pounds by summer's end, for an average grazing-season weight of 788.5 pounds. Hence the AUE for steers is 0.876 and 0.837 for heifers. Native hay is assumed to be purchased, either from the operation's own hay enterprise or off-farm, to support the herd from November 15 to April 15. Cattle sales for the operation occur in the fall, and include yearlings and cull animals. Mean livestock prices underlying this budget are reported in appendix 1. Ruff et al. (2014a, table 3) provides a complete list of all prices underlying the budget. Ruff (2013) provides full details of the cow-calf-yearling operation.

Stocker operation

Alternatively, the operation's existing forage-base is assumed to be capable of supporting 969 steers (post-transition); these steers are purchased May 1 weighing 600 pounds each. We assume a two percent death loss on stockers throughout the grazing season. Thus, on September 10, 950 steers are sold at 846 pounds, after being fed for 10 days prior to marketing. We assume stockers, in the absence of a cow-herd's calming presence, require extra labor when moving and handling. Specifically, once the transition to a stocker operation is complete, we assume twice as much labor is needed during each livestock-management activity, compared to the cow-calf-yearling operation. Additionally, we assume fencing costs (repair and replacement) are triple those of the cow-calf-yearling operation. These assumptions are based on a producer-group interview (Northwestern Wyoming Cattle Producers, 2013). Mean livestock prices assumed in the stocker budget are reported in Appendix 1. Ruff et al. (2014b, Table 3) provides a complete list of prices underlying the budget. Ruff (2013) provides full details of the stocker operation.

Transition strategies

One way to transition to a stocker operation is to sell all breeding cattle at the same time. For this abrupt transition strategy, we assume the cow-calf-yearling herd is liquidated in the fall, and replaced with stockers the following spring. However, it could be difficult to locate enough stocker calves in the surrounding area within such a short period, in which case a producer may have to purchase calves from long distances, incurring large transportation costs.

A producer could address these challenges through two adjustments to the transition strategy: 1) by transitioning over several years, allowing enough time to seek out reliable long-term suppliers of stocker calves; and 2) timing the purchase and weight-class of stockers to take advantage of calving trends in the surrounding area. For example, most cow-calf operations in Wyoming calve in the spring (Strauch, Peck, and Held, 2010), so a stocker operation in northwest Wyoming searching for calves to purchase in May should expect heavier-weight calves (i.e., spring-born calves) to be more abundant at that time than lighter-weight calves (i.e., fall-born calves). Keeping these two features in mind – a gradual transition and stocker-calf availability – we describe a 7-year transition strategy in more detail below. Lastly, we quantify the two transition strategies' costs and benefits relative to the cow-calf-yearling operation.

Under a 7-year transition strategy, a producer could transition to stockers gradually by making use of their cow-calf-yearling operation's normal culling practices. Each year in the study area, roughly 15 percent of any given breeding herd is culled. These culled animals would not be offset by the usual retention of heifer calves chosen as future replacements. Instead, those heifer calves would be spayed and transferred into the yearling enterprise. As a result, the breeding herd would slowly shrink, while the yearling herd would expand.

During the first few years of transition, the operation's cow-calf enterprise can supply almost enough calves to the yearling enterprise to consume all AUEs freed-up by culling. In year 1, only 10 calves must be purchased off-farm to make full-use of the operation's grazing resources. We assume these off-farm calves are purchased in the fall (the start of the production calendar for year 1), at the same weight as the operation's own calves, so they can be managed together. By year 4, more than half of all calves are purchased off-farm because the breeding herd is so small.

At the end of the year 6 production calendar–in early November–the last of the breeding animals are sold, and their calves are transferred to the yearling enterprise. This leaves 887 yearlings to graze the following summer (in year 7); 870 survive the grazing season, to be fed for 10 days before marketing on September 10 at 927 pound (for spayed heifers) and 977 pounds (for steers). In year 8, the operation becomes a full-fledged stocker operation – idle during much of the winter before purchasing stocker-calves (steers only) in May, at 600 pounds, grazing them through the summer, and selling them in the fall at 846 pounds. The operation's forage resources will support 969 of these steers; 950 will survive the grazing season, to be fed for 10 days before marketing on September 10 (approaching the end of year 8). Full details are provided in Ruff (2013).

This gradual, multi-year transition is designed specifically to keep the operation's production schedules as similar to the base operation as possible, until year 8, when they become a stand-alone, spring-purchased, 600-pound stocker operation. This transition strategy addresses some challenges that otherwise plague a single-year strategy. It gradually phases-in labor and management changes, and gives the producer time to locate reliable long-term suppliers of stocker calves.

Net present value analysis

Given the different timeframes of the two transition strategies (one year versus seven years), they should be compared by estimating their net present value (NPV) (Barry, et al., 2000, 249-343). This involves discounting a strategy's stream of revenues and costs through time to a common period, before summing across all years to find NPV, as described in equation (2).

$$\text{(2)} \quad NPV = P_1/(1+i)^1 + P_2/(1+i)^2 \ldots + P_n/(1+i)^n + V_n/(1+i)^n$$

P_n is the stream of net revenue (or more specifically, returns over cash costs) experienced over *n* years; *i* is the discount rate; and V is the salvage value (when applicable). For the discount rate, we initially assume a risk-free real interest rate of two percent, to be consistent with a previous analysis by Roberts (2011). This enables producers to directly compare "switching to stockers" with other brucellosis management strategies described in Roberts (2011).

Recognizing, however, that agricultural loans may be subject to risk-premiums, and that some producers place a higher value on the present than the future, we experiment with a real discount rate of four percent. We also tested a discount rate of six percent, but it generates similar conclusions as a four percent discount rate. Thus, for brevity, we report results only for discount rates of zero, two, and four percent. A discount rate of zero percent is included to show dollar values before any adjustments for time-preferences are made.

We also calculate each strategy's NPV over three different planning horizons: 8, 20, and 30 years. Planning horizon is relevant because the transition strategies are compared against a baseline strategy, and this baseline might differ for younger versus older producers. For example, a younger producer's baseline strategy might be to, "Run cow-calf-yearlings until I retire in 30 years, when I will liquidate the herd...decades from now." In contrast, an older producer's baseline strategy might be to, "Run cow-calf-yearlings until I retire in 8 years, when I will liquidate the herd…just a few short years from now." Thus, a younger producer who considers the transition to stockers faces a different decision context than an older producer. For a younger producer, the transition would involve liquidating their cow-calf-yearling herd decades sooner than planned (dramatically changing the present-value of the herd's sale-proceeds) and running stockers for decades thereafter (dramatically changing the flow of net revenue through time for many years). For an older producer, the transition would involve liquidating their cow-calf-yearling herd just a few years earlier than planned and running stockers only briefly before retiring.

Although both producers debate the same general question – whether to transition to stockers or not – the younger producer's tradeoffs span a very different timeframe than the older producer's. Thus the benefits and costs of transitioning, when discounted into present-value terms, may be quite different. Furthermore, by calculating NPV for three different planning horizons – 8, 20, and 30 years – producers at different stages of their career can relate directly to our findings without extrapolation.

Risk analysis

Given the volatile nature of cattle prices (both at purchase and sale), producers might be concerned not only about average profit, but also year-to-year variation in profit. We therefore use Monte Carlo simulation to quantify and compare financial risk – due to random variation in prices only – for the cow-calf-yearling and stocker operations (Robert and Casella, 1999). The simulation software, @Risk, is an add-in to Microsoft Excel© (Palisade Corporation, 2013). It recalculates returns over cash costs (ROCC) and net present value (NPV) for a given cattle operation 10,000 times (i.e., over 10,000 iterations). Each iteration uses a different set of prices to complete the calculations, which are drawn randomly from pre-determined probability distributions. By re-calculating ROCC and NPV 10,000 times for a given cattle operation, we can report them as probability distributions, rather than point-estimates. This allows us to compare the two operation types and two transition strategies not only in terms of averages, but also standard deviation, coefficient of variation, and probability of experiencing a net gain or loss.

Prices for the following inputs and outputs are allowed to vary across iterations: steer calves, heifer calves, yearling steers, yearling heifers, bred heifers (i.e., first-calf heifers), bred two-year-olds (i.e., second-calf heifers), bred cows (young, middle, and aged), and hay. All cattle prices are provided by the Livestock Marketing Information Center (LMIC), which includes monthly prices for years 1999 through 2012 (LMIC, 2013). We adjust these nominal prices to 2010 real prices using the US Bureau of Labor Statistics' Producer Price Index for all food. We then select prices for a 3-month window around the purchase-date or sales-date of interest. For example, for 800-900-pound feeder steers sold in September, we select prices from August through October of each year. Finally, we fit a probability distribution to this subset of real price data using @Risk's "distribution fitting" tool. This tool uses maximum likelihood estimation to fit several different distributions to the data; it then uses the Akaike Information Criterion to measure goodness-of-fit and recommend a distribution (Vose, 2003).

Parameter values for the eleven distributions used in our risk analysis are described in Appendix 1. In addition to the standard parameter values, each distribution has a truncated lower and upper bound (based on the dataset's lowest and highest price, and standard deviation), as well as Pearson's correlation coefficients between any variables that tend to move together (reported in Appendix 2).

Results

Enterprise budgets

Comparison of the budget summaries in Table 1 reveals an advantage for the cow-calf-yearling operation over the stand-alone stocker operation, measured in returns over total cost, and based on average prices (which are reported as means in Appendix 1; for a complete list of prices, see Table 3 in Ruff et al. 2014a and 2014b). The cow-calf-yearling operation generates $552,928 in revenue, of which $251,987 is from the cow-calf enterprise and the other $300,941 is from the yearling enterprise. Total cash cost for this operation is $511,187. Major costs for the cow-calf enterprise include: winter feeding and summer grazing; spring calving; gathering, trailing and sorting; fuel; replacement bulls, and horse-related costs. Major costs for the operation's yearling enterprise include: purchasing calves, winter feeding and grazing; and marketing costs. Ruff et al. (2014a) provides more detailed cost information, but returns over cash costs (ROCC) are estimated at $41,741. This is more than twice the stocker operation's ROCC, which is discussed later. After accounting for ownership costs of $63,065 – which includes interest on operating loans, depreciation of equipment, and owner labor – the cow-calf-yearling operation's pre-tax returns over total cost is -$21,324, on average, which represents a net-loss. If ownership or other costs are not reduced, this production system will not be economically sustainable, on average, in the long-run.

The stand-alone stocker operation (spring purchased, 600-pound steers) offers higher total revenue, $956,724, than the cow-calf-yearling operation (Table 1). Its largest expense category is the purchase of stocker calves, $786,983, which offsets 82 percent of total revenue. The calves must gain enough weight over the next 132 days to also cover $150,556 of costs incurred during grazing, trailing, trucking, marketing and other production activities. The operation's ROCC is just $19,185, less than half of the cow-calf-yearling operation's ROCC. This slim margin between revenues and costs highlights the importance of the buy-sell margin for stocker cattle (Nader et al., 2010). After accounting for ownership costs of $77,795, the stocker operation's pre-tax returns over total cost is -$58,789, on average, which represents a sizable net-loss. Overall, these results show the cow-calf-yearling operation to be twice as profitable, on average, as the stocker operation. Neither operation is profitable on average though.

Next, we vary the most critical prices in the budgets, using Monte Carlo simulation, to quantify financial risk – specifically the variability of ROCC. Note that ownership costs are assumed constant. The simulation results (bottom half of Table 1) indicate that stockers enjoy a higher maximum ROCC than cow-calf-yearlings, but also suffer higher variability in ROCC (as measured by the coefficient of variation). Furthermore, stockers have a much higher chance of experiencing negative ROCC (i.e., a net loss), 43 percent versus 13 percent (Table 1). Lastly, in 67 percent of iterations, the difference between ROCC for the two operations shows cow-calf-yearlings having an advantage over stockers. Collectively, these results support previous studies' conclusions that cow-calf-yearling operations are generally more profitable and less risky than stocker operations (e.g., Ritten et al., 2010; Roberts, 2011), when compared side-by-side without considering a transition process.

Transition analysis

Most studies would go no further in their comparison of cow-calf-yearling versus stocker operations. After all, producers would not typically be interested in transitioning to an enterprise that generates less profit and more financial risk. Recall, however, that herds in the GYA face a risk of contracting and being quarantined for brucellosis. To reduce this risk, some producers might be interested in transitioning to a stocker operation, even if it is less profitable and riskier financially. In such cases, it would be helpful for them to know which transition strategy performs best, and what additional benefits and costs might arise during the transition process. The enterprise budgets we presented earlier ignored the transition process entirely, along with any associated benefits and costs, such as shifts in the timing of sale-proceeds from the cow-calf-yearling herd liquidation. We therefore turn our attention to the much-overlooked transition process.

Table 2 shows, for an eight-year planning horizon, average annual ROCC for each year of the 1-year (abrupt) and 7-year (gradual) transition strategies, versus for the cow-calf-yearling operation. The 1-year transition generates lower total ROCC (assuming a 0% discount rate) than cow-calf-yearlings. The 1-year transition has a large ROCC in the first year, $497,438, due to sale-proceeds from the upfront liquidation of all breeding livestock (see Ruff [2013] for valuation details). But its ROCC is much lower in subsequent years ($19,185 versus $41,741), reflecting the poorer average performance of a stocker operation during the post-transition phase.

The 7-year transition, in contrast, generates higher total ROCC (assuming a 0% discount rate) than cow-calf-yearlings. During years one through seven, in particular, the 7-year transition's ROCC is higher than the cow-calf-yearling operation's. Year 1 is highest, $169,467, followed by a slight decline during year 2 to $125,218, then rising for several years before dropping dramatically in years 7 and 8. This pattern reflects declining sales of breeding livestock coupled with rising sales of yearlings. Closer inspection of this pattern suggests that the optimal mix of yearlings within the cow-calf-yearling herd might be higher than assumed in our baseline cow-calf-yearling budget. This raises an interesting research question that it is beyond the scope of our paper. Nevertheless, the 7-year transition strategy generates the highest total ROCC across an eight-year planning horizon, compared to the 1-year transition strategy and cow-calf-yearling operation, assuming average prices.

Recognize, though, that the total ROCCs reported in table 2 ignore price variability, as well as time-value of money and different planning horizons. Tables 3 and 4, in contrast, report the Monte Carlo simulation results for NPV of ROCC over 8, 20 and 30-year planning horizons, assuming two and four percent discount rates, respectively.

The first result that emerges from Tables 3 and 4 is that a 1-year transition to stockers always performs worse than a 7-year transition, measured in terms of mean-NPV. This holds true across all planning horizons and both discount rates. The 1-year transition also suffers a greater risk of negative NPV and a higher coefficient of variation than the 7-year transition – across all planning horizons and discount rates. This suggests that a producer can expect an abrupt transition to stockers to generally be less profitable and more risky than a gradual transition.

An abrupt transition may also have different tax implications than a gradual transition, though we do not conduct a tax analysis in this paper. Accounting methods (cash versus accrual), deductions, and other tax-relevant characteristics vary so much across operations that it would be difficult to provide a meaningful analysis. Producers should therefore consult with their legal and tax advisors to discuss other ramifications of a 1-year versus 7-year transition before making a transition decision.

A second result that emerges from Tables 3 and 4 is that the 7-year transition generates higher NPV than the cow-calf-yearling operation for almost every planning horizon and discount rate. The only exception is the 30-year planning horizon with a two percent discount rate, in which the two operations generate similar mean NPV. Once the discount rate is increased to four percent, though, the 7-year transition yields the highest mean NPV, across all planning horizons. It outperforms not only the cow-calf-yearling operation, but also the 1-year transition as mentioned earlier.

The 7-year transition's performance over the cow-calf-yearling operation reflects the strong influence of time-value of money on NPV. A producer who is relatively impatient – for example, if they have a four percent personal discount rate, they would be willing to accept $0.96 today rather than waiting a year to receive $1.00 – derives more satisfaction from liquidating their breeding livestock sooner (via the 7-year transition to stockers) than later (upon retirement as a cow-calf-yearling operator). That being said, a four percent personal discount rate is not high enough for the 1-year transition to outperform the 7-year transition, even though a 1-year transition would generate sale-proceeds even sooner. This is because the 1-year transition requires a producer to give up too much NPV, overall, in exchange for receiving it sooner. In contrast, a 7-year transition strikes a better balance between NPV's magnitude and timing.

Recall from our earlier budget analysis (Table 1) that average ROCC for a single year is higher for cow-calf-yearlings ($41,741) than for stockers ($19,185). It might come as a surprise then that a 7-year transition to stockers suddenly looks more appealing than a cow-calf-yearling operation (Tables 3 and 4). Like most budget analyses, though, Table 1 completely ignored the transition process, pretending instead that a cow-calf-yearling operation could transform instantaneously into a stocker operation without any transition costs or benefits.

In reality, the transition process does generate additional ROCC, especially during the first few years of the planning horizon. Yet the upfront benefit of receiving this additional ROCC must be large enough to outweigh the eventual downside of stockers – a lower annual ROCC ($19,185). A producer's personal discount rate must therefore be sufficiently high (e.g., 4%), or the planning horizon sufficiently short (e.g., 20 years). Otherwise, the upfront benefits will not be large enough to outweigh the eventual costs – a stocker operation's lower annual ROCC (a loss that accumulates with each passing year). Conversely, if a producer's personal discount rate is relatively low (e.g., 2%) and the planning horizon is long (e.g., 30 years), then the 7-year transition's upside (i.e., receiving additional ROCC upfront) will not outweigh its downside (i.e., lower annual ROCC in the longer-run). In this case, the cow-calf-yearling operation will prevail because its higher annual ROCC ($41,741) will outweigh the foregone opportunity of greater upfront ROCC (which is sacrificed by choosing to keeping the breeding herd until retirement).

Figure 1 illustrates the flow of annual average ROCC over a 30-year planning horizon for the cow-calf-yearling operation and two stocker-transition strategies. Panels (a) and (b) demonstrate the effect of a higher discount rate on the flow of ROCC. The cow-calf-yearling scenario is impacted most because the proceeds from herd-liquidation occur in year 30 (highly discounted), rather than upfront (lightly discounted). Panels (c) and (d) depict the accumulation of annual average ROCC through time, eventually reaching NPV in year 30. In panel (c), where the discount rate is low (0%) and planning horizon is long (30 years), the cow-calf-yearling operation achieves the highest NPV (see data-points at year 30). But in panel (d), where the discount rate is higher (4%), the 7-year transition to stockers achieves the highest NPV.

For the 20-year planning horizon (not shown in Figure 1; see Appendix 3), an increase in the discount rate causes a similar switch in the optimal strategy from cow-calf-yearling to 7-year transition. When applied to an 8-year planning horizon (Appendix 3), an increase in the discount rate has no impact on the optimal strategy. The 7-year transition to stockers consistently dominates the cow-calf-yearling operation (in terms of mean NPV). This illustrates the moderating effect that planning horizon has on the discount rate; hence, the importance of defining a specific planning horizon before deciding whether to transition. Appendix 3 presents, in table format, the flow of annual average ROCC across the three planning horizons and three discount rates. These numbers underlie Figure 1.

Although the 7-year transition to stockers almost always outperforms cow-calf-yearling, in terms of mean-NPV, it almost always exhibits greater financial risk, particularly if the planning horizon is 20 or 30 years. Under these longer planning horizons, the 7-year transition suffers a higher coefficient of variation and a higher probability of NPV being negative than the cow-calf-yearling operation. This reflects again a stocker operation's narrow buy-sell margin. Continue too long as a stocker operator in the risky post-transition phase (when breeding livestock are no longer available to liquidate), and the high levels of financial risk reported in Table 1 will eventually overwhelm the low levels enjoyed during the transition phase (tables 3 and 4).

If the planning horizon is relatively short (e.g., 8 years) – representing perhaps a producer who is close to retirement – the 7-year transition to stockers has similar financial risk as the cow-calf-yearling operation. Given higher mean-NPV and no-higher risk, a 7-year transition to stockers appears to be an attractive way to remain active in the cattle industry while working towards retirement within the next 8 years. A producer who chooses this option enjoys proceeds from the gradual herd-liquidation along the way, rather than having to wait until the final year of the planning horizon to enjoy an influx of income. That being said, risk preference, management ability, cattle price-cycle phase, and tax liability are additional factors they may want to consider.

Discussion and Conclusions

Previous studies often report lower returns and higher variability for stocker operations compared to cow-calf-yearling operations, when compared side-by-side without considering a transition from one to the other. Our enterprise budget analysis and stochastic simulation support these same findings for northwestern Wyoming. This study's unique contribution to the literature, though, is its analysis of the transition process itself, which has largely been ignored in the literature and perhaps by some farm managers and consultants as well.

Our results suggest that, when transition-related benefits and costs are considered, a gradual transition to a stocker operation can actually generate higher NPV of ROCC (on average) than a cow-calf-yearling operation, depending on the transition strategy, planning horizon, and discount rate. This may seem contradictory at first to our earlier enterprise budget analysis findings, which indicated that cow-calf-yearlings are more profitable on average than stockers. Recall, though, that the budget analysis completely ignores the transition process, and instead compares two well-established operations, i.e., two operations already in the post-transition phase. In reality, a producer who wishes to transform their operation from cow-calf-yearlings to stockers (perhaps to reduce brucellosis-quarantine risk) cannot achieve this instantaneously; they must undertake a transition process. During transition, they will encounter additional benefits and costs, which standard enterprise budget analysis does not capture. Our NPV analysis accounts for these transition benefits and costs. And it suggests that a gradual transition to stockers, under specific circumstances, can generate more NPV than a cow-calf-yearling operation.

Nonetheless, the transition and post-transition phases of a stocker operation involve greater financial risk than remaining in the cow-calf-yearling sector, especially if a producer has a relatively low discount rate or plans to remain in the cattle industry for 20 years or longer. This increased financial risk may be of serious concern for producers, as well as their lenders. The tradeoff between higher average NPV and higher financial risk becomes more pronounced as the planning horizon increases, largely because the chance for stockers to suffer negative ROCC increases. For producers less than a decade away from retirement, though, or for those with higher discount rates, it might be worth considering a gradual transition away from cow-calf-yearling, and towards stockers-only, rather than simply liquidating all breeding livestock at once when they retire. They could also consider transitioning gradually out of cow-calf-yearlings without transitioning into stockers at all (an idea that requires additional research beyond the scope of our paper). Again, risk preference, management ability, cattle price-cycles, and tax liability are additional factors they may want to consider before making this decision.

For producers in the Designated Surveillance Area of the GYA – whose herds are at risk of being quarantined for brucellosis, but who might not want to transition out of the cattle industry entirely – converting to stockers would eliminate brucellosis-related risk. And our results suggest that, if a producer has a relatively high discount rate or is within eight years of retirement (with no intent of passing the operation on to the next generation, which would effectively extend the planning horizon), a gradual transition to stockers might be worth considering. It generates higher NPV than running cow-calf-yearlings until retirement, and it enables them to maintain a familiar lifestyle, but it also increases their financial risk. Another shortcoming is that, as long as a herd contains any breeding cattle (no matter how few) it is at risk of being quarantined. This complicates the comparison of a 1-year versus 7-year transition. A 1-year transition reduces the risk of brucellosis most quickly, but comes at the cost of a large decrease in mean NPV, and a large increase in the risk of negative ROCC. Conversely, a 7-year transition lessens the financial cost and risk of switching to stockers, but leaves the operation vulnerable to the risk of brucellosis quarantine for longer.

Our results show that switching to stockers cannot reduce the risk of brucellosis quarantine while maintaining the same level of profitability *and* the same level of financial risk as a cow-calf-yearling operation. Tradeoffs between different types of risk – brucellosis versus financial – are unavoidable. When considering these tradeoffs, a producer in the DSA should weigh the potential benefits of switching to stockers against its potential costs. More specifically, they should compare the probability-weighted cost of their cow-calf-yearling herd being quarantined for brucellosis during their planning horizon (Wilson, 2011) against a potential change in mean NPV and increase in financial risk over that same planning horizon.

If the benefits of transitioning to stockers seem to outweigh the costs, they should consider next whether some other brucellosis management activity (e.g., adult-booster vaccination, fencing winter pastures, or transitioning out of the cattle industry entirely) might generate even larger net present value (Roberts et al., 2012; Boroff, 2013). The results of our study provide certain pieces of information, that are necessary but not sufficient for ranch managers (along with their advisors and consultants) to make this difficult and very personal decision. Our results also provide policymakers with pieces of information they would need to design, and debate the merits of, an incentive program related to cow-calf-yearling operations transitioning to stockers.

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Table 1. Enterprise analysis for cow-calf-yearling and stocker operations, using average prices initially, followed by simulation of returns over cash costs using price distributions

	Cow-Calf-Yearling	**Stocker, Post-Transition**
Total Revenue	$552,928	$956,724
Cash Costs (major categories)		
Purchasing calves	$193,654	$786,983
Feeding	$213,428	$42,625
Gathering, trailing, trucking, sorting	$12,840	$33,944
Calving	$8,259	$0
Marketing	$22,002	$33,560
Other	$61,004	$40,427
Returns Over Cash Costs (ROCC)	$41,741	$19,185
Ownership Costs	$63,065	$77,975
Returns Over Total Cost	-$21,234	-$58,789
Simulation of ROCC		
Mean	$41,724	$19,208
Minimum	-$342,483	-$188,141
Maximum	$146,973	$312,605
Standard Deviation	39,373	70,710
Coefficient of Variation	0.94	3.68
Probability of Negative ROCC	13%	43%
# of Iterations	10,000	10,000

Note: detailed enterprise budgets are described in Ruff et al. (2014a, 2014b).

Table 2. Estimated annual returns over cash costs for a cow-calf-yearling operation versus a 1-year or 7-year transition to a stocker operation, using average prices and a 0% discount rate.

Year	Cow-Calf-Yearling	1-Year Transition to Stockers	7-Year Transition to Stockers
1	$41,741	$497,438	$169,467
2	$41,741	$19,185	$125,218
3	$41,741	$19,185	$130,556
4	$41,741	$19,185	$133,222
5	$41,741	$19,185	$136,889
6	$41,741	$19,185	$144,599
7	$41,741	$19,185	$67,608
8	$497,438[a/]	$19,185	$19,185
Total	$789,625	$631,733	$926,744

[a/]The cow-calf-yearling herd, when liquidated all at once, generates sale-proceeds of $497,438 (before discounting).

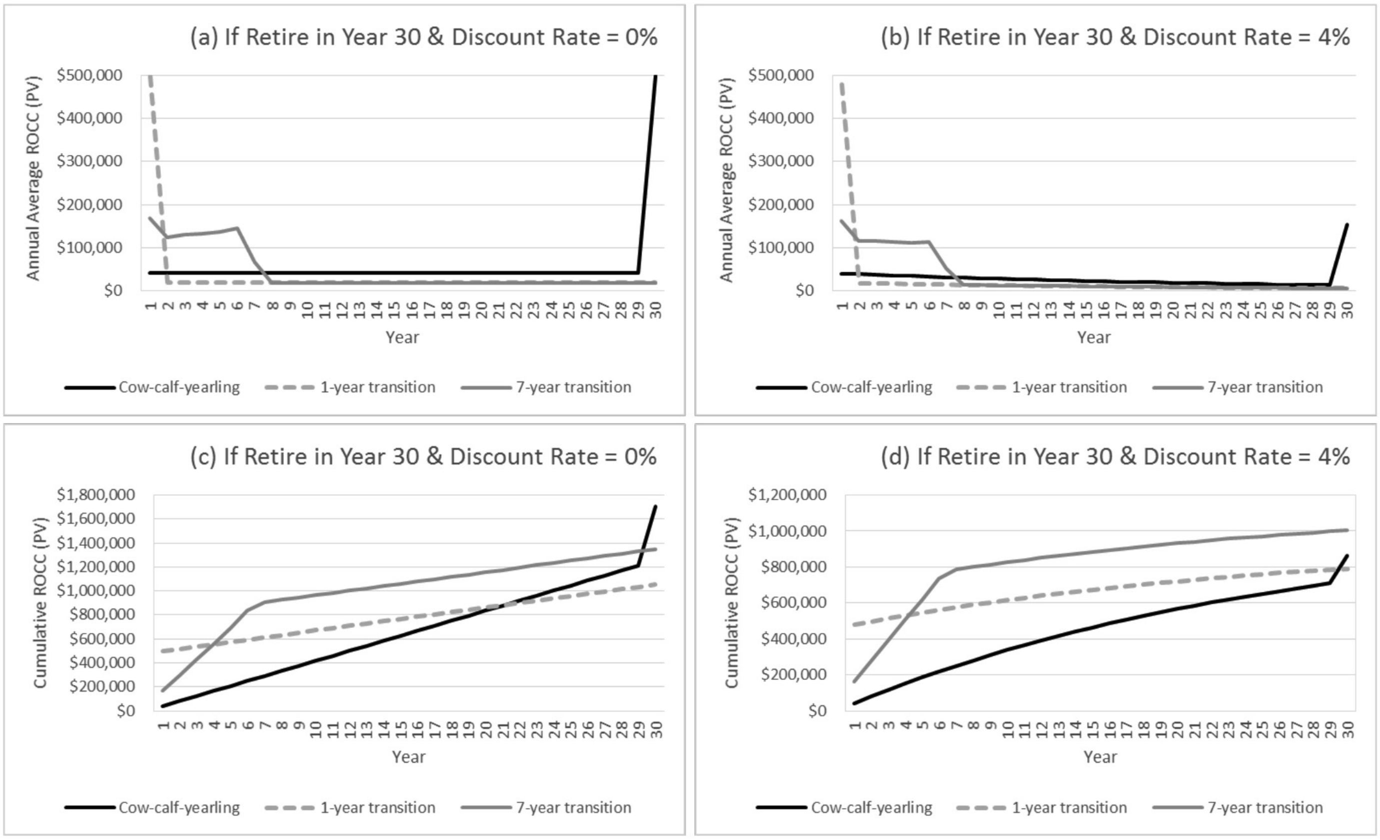
Table 3. Monte-Carlo simulation of the net present va.lue of returns over cash costs (pre-tax) for a cow-calf-yearling operation versus a 1-year or 7-year transition to a stocker operation, using an 8, 20, or 30-year horizon, a 2% discount rate, and 10,0000 iterations.

Planning Horizon	Cow-Calf-Yearling	1-Year Transition to Stockers	7-Year Transition to Stockers
8 Year			
Mean	$691,974	$609,645	$857,903
Minimum	-$2,068,547	-$788,975	-$1,658,261
Maximum	$1,614,596	$2,906,932	$2,189,059
Std. Deviation	326,024	492,568	411,818
Coeffic. of Variation	0.47	0.81	0.48
Prob. of Neg. NPV	1.9%	7.9%	1.4%
20 Year			
Mean	$979,659	$781,070	$1,029,328
Minimum	-$5,065,214	-$2,577,817	-$2,183,981
Maximum	$2,829,684	$6,048,505	$5,330,633
Std. Deviation	673,864	1,122,826	968,156
Coeffic. of Variation	0.69	1.44	0.94
Prob. of Neg. NPV	6.4%	25%	12.8%
30 Year			
Mean	$1,170,668	$894,888	$1,143,146
Minimum	-$7,054,846	-$3,765,516	-$2,721,138
Maximum	$3,636,440	$8,134,348	$7,416,476
Std. Deviation	905,457	1,542,912	1,375,109
Coeffic. of Variation	0.77	1.72	1.20
Prob. of Neg. NPV	8.7%	29.7%	20%

Table 4. Monte-Carlo simulation of the net present value of returns over cash costs (pre-tax) for a cow-calf-yearling operation versus 1-year or 7-year transition to a stocker operation, using an 8, 20, or 30-year horizon, a 4% discount rate, and 10,000 iterations.

Planning Horizon	Cow-Calf-Yearling	1-Year Transition to Stockers	7-Year Transition to Stockers
8 Year			
Mean	$614,647	$590,078	$801,018
Minimum	-$1,927,438	-$687,675	-$1,535877
Maximum	$1,457,087	$2,700,942	$2,014,825
Std. Deviation	298,476	453,165	378,066
Coeffic. of Variation	0.49	0.77	0.47
Prob. of Neg. NPV	2.1%	6.6%	1.4%
20 Year			
Mean	$775,549	$721,785	$932,725
Minimum	-$4,280,144	-$2,062,050	-$1,939,790
Maximum	$2,308,910	$5,114,626	$4,428,509
Std. Deviation	560,473	936,688	797,595
Coeffic. of Variation	0.72	1.30	0.86
Prob. of Neg. NPV	7.3%	22.4%	9.9%
30 Year			
Mean	$862,403	$792,880	$1,003,820
Minimum	-$5,550,129	-$2,803,934	-$2,157,821
Maximum	$2,768,722	$6,417,527	$5,731,410
Std. Deviation	702,384	1,198,860	1,048,581
Coeffic. of Variation	0.81	1.51	1.04
Prob. of Neg. NPV	9.4%	26.2%	15.9%

Figure 1. Flow of annual average ROCC (returns over cash costs), over a 30-year planning horizon, assuming a discount rate of 0 or 4%. Panels (a) and (b) show annual average ROCC by year for cow-calf-yearling, 1-year transition to stockers, and 7-year transition to stockers. Panels (c) and (d) show ROCC accumulating across the planning horizon, where the value at year 30 represents net present value.



Note: all values are adjusted to US$2010 and reported in present-value terms to account for the time-value of money.

Appendix 1. Distributions, parameter values, and descriptive statistics for prices in the cow-calf-yearling and stocker models.

	Distributional assumptions[b/]						*Distributional statistics*		
Price series[a/]	@Risk distribution	Param-eter 1	Param-eter 2	Param-eter 3	Lower bound	Upper bound	Mean	Standard deviation	Coefficient of variation[c/]
Cow-calf-yearling enterprise ($/cwt)									
Steers, 5-6 cwt, oct-dec	LogLogistic	γ=82.54	β=49.82	α=4.60	80.00	200.00	134.58	18.60	0.14
Heifers, 5-6 cwt, oct-dec	Logistic	α=120.63	β=9.19	--	75.00	175.00	120.84	15.74	0.13
Steers, 9-10 cwt, aug-oct	Normal	μ=114.36	σ=12.80	--	80.00	150.00	114.40	12.46	0.11
Heifers, 9-10 cwt, aug-oct[d/]	Normal	μ=114.65	σ=13.14	--	80.00	150.00	114.67	12.73	0.11
Bred heifers, 9-10 cwt, oct-dec	Normal	μ=107.00	σ=15.00	--	75.00	152.00	107.00	14.00	0.13
Breds 2-5 yrs, 10-12 cwt, oct-dec	Triang	min=60	m.lik.=79	max=120	60.00	120.00	86.00	13.00	0.15
Breds 6-10 yrs, 12 cwt, oct-dec	Extvalue	a=71.00	b=10.00	--	55.00	110.00	76.00	11.00	0.14
Breds 11-14 yrs, 12 cwt, oct-dec	Triang	min=40	m.lik.=50	max=96	40.00	96.00	62.00	12.00	0.19
Open/cull repl. heifers, 9 cwt, 2010 avg	--	--	--	--	--	--	108.00	0.00	0.00
Open/cull 2-yr olds, 10 cwt, 2010 avg	--	--	--	--	--	--	61.00	0.00	0.00
Open/cull 3+ yrs, 12 cwt, 2010 avg	--	--	--	--	--	--	57.00	0.00	0.00
Cull bulls, 16.5 cwt, 2010 avg	--	--	--	--	--	--	70.00	0.00	0.00
Cull horses, 10 cwt, 2010 avg	--	--	--	--	--	--	20.00	0.00	0.00
Stocker enterprise ($/cwt)									
Steers, 5-7 cwt, apr-jun[e/]	Logistic	α=135.24	β=7.24	--	95.00	185.00	135.36	12.68	0.09
Steers, 8-9 cwt, aug-oct	Extvalue	a=112.85	b=11.46	--	75.00	170.00	119.04	13.79	0.12
Native hay enterprise ($/ton)									
Native hay, 1985-2012[f/]	LogLogistic	γ=84.07	β=14.08	α=2.55	70.00	400.00	102.29	16.84	0.16

[a/] From the Livestock Marketing Information Center, years 1999-2012 (unless noted). All prices adjusted to real US$2010.

[b/] Derived in @Risk by fitting candidate probability distributions to the historical real price series, then choosing the best-fit according to the Akaike Information Criterion (Vose, 2003), and truncating it based on historical highs, lows, and standard deviation.

[c/] Coefficient of variation = standard deviation ÷ mean. A standardized measure of dispersion that allows comparison of variables with different means. Larger coefficient of variation indicates more variability.

[d/] Based on data for 800-900-lb heifers, due to limited observations from Torrington, Wyoming for 900-1000-lb heifers.

[e/] The 600-lb weight-class falls between two price series, 500-600 and 600-700, so we took a simple average of the two.

[f/] Hay prices represent annual-averages for the entire state of Wyoming.

Appendix 2. Correlation coefficients assumed between price distributions in the cow-calf-yearling and stocker models.[a]

		Cow-calf-yearling price variables								*Stocker*	
		Steers, 5-6 cwt, oct-dec	Heifers, 5-6 cwt, oct-dec	Steers, 9-10 cwt, aug-oct	Heifers, 9-10 cwt, aug-oct	Bred heifers, 9-10 cwt, oct-dec	Breds 2-5 yrs, 10-12 cwt, oct-dec	Breds 6-10 yrs, 12 cwt, oct-dec	Breds 11-14 yrs, 12 cwt, oct-dec	Steers, 5-7 cwt, apr-jun	Steers, 8-9 cwt, aug-oct
Cow-calf-yearling price variables	Steers, 5-6 cwt, oct-dec	1.00									
	Heifers, 5-6 cwt, oct-dec	0.63	1.00								
	Steers, 9-10 cwt, aug-oct	0.49	0.71	1.00							
	Heifers, 9-10 cwt, aug-oct	0.57	0.80	0.98	1.00						
	Bred heifers, 9-10 cwt, oct-dec	0.90	0.73	0.79	0.83	1.00					
	Breds 2-5 yrs, 10-12 cwt, oct-dec	0.89	0.82	0.71	0.80	0.90	1.00				
	Breds 6-10 yrs, 12 cwt, oct-dec	0.90	0.81	0.69	0.76	0.91	0.94	1.00			
	Breds 11-14 yrs, 12 cwt, oct-dec	0.89	0.86	0.71	0.89	0.93	0.97	0.94	1.00		
Stocker	Steers, 5-7 cwt, apr-jun	0.43	0.74	0.80	0.85	0.62	0.78	0.70	0.72	1.00	
	Steers, 8-9 cwt, aug-oct	0.49	0.59	0.98	0.95	0.78	0.70	0.66	0.68	0.78	1.00

[a] We assume zero correlation between hay and cattle prices because of the complex and lagged relationships between these sectors.

Appendix 3. Annual average ROCC (returns over cash costs) by year, across a planning horizon of 8, 20, or 30 years (rows) and a discount rate of 0, 2, or 4% (columns). Three strategies are analyzed: cows-calf-yearling, 1-year transition to stockers, and 7-year transition to stockers.

	If discount rate is 0%			*If discount rate is 2%*			*If discount rate is 4%*		
Year	**Cow-Calf-Yearling**	**1-Year Transition to Stockers**	**7-Year Transition to Stockers**	**Cow-Calf-Yearling**	**1-Year Transition to Stockers**	**7-Year Transition to Stockers**	**Cow-Calf-Yearling**	**1-Year Transition to Stockers**	**7-Year Transition to Stockers**
1	$41,741	$497,438	$169,467	$40,923	$487,684	$166,144	$40,136	$478,306	$162,949
2	$41,741	$19,185	$125,218	$40,120	$18,440	$120,356	$38,592	$17,738	$115,771
3	$41,741	$19,185	$130,556	$39,333	$18,078	$123,026	$37,108	$17,055	$116,064
4	$41,741	$19,185	$133,222	$38,562	$17,724	$123,077	$35,680	$16,399	$113,879
5	$41,741	$19,185	$136,889	$37,806	$17,376	$123,985	$34,308	$15,769	$112,513
6	$41,741	$19,185	$144,599	$37,065	$17,036	$128,400	$32,989	$15,162	$114,279
7	$41,741	$19,185	$67,608	$36,338	$16,702	$58,857	$31,720	$14,579	$51,377
8	$497,438 or $41,741[a/]	$19,185	$19,185	$424,559 or $35,626	$16,374	$16,374	$363,473 or $30,500	$14,018	$14,018
NPV if retire in yr 8[b/]	**$789,625**	**$631,733**	**$926,744**	**$694,706**	**$609,415**	**$860,218**	**$614,005**	**$589,026**	**$800,849**
9	$41,741	$19,185	$19,185	$34,927	$16,053	$16,053	$29,327	$13,479	$13,479
10	$41,741	$19,185	$19,185	$34,242	$15,738	$15,738	$28,199	$12,961	$12,961
11	$41,741	$19,185	$19,185	$33,571	$15,430	$15,430	$27,114	$12,462	$12,462
12	$41,741	$19,185	$19,185	$32,912	$15,127	$15,127	$26,071	$11,983	$11,983
13	$41,741	$19,185	$19,185	$32,267	$14,831	$14,831	$25,069	$11,522	$11,522
14	$41,741	$19,185	$19,185	$31,634	$14,540	$14,540	$24,104	$11,079	$11,079
15	$41,741	$19,185	$19,185	$31,014	$14,255	$14,255	$23,177	$10,653	$10,653
16	$41,741	$19,185	$19,185	$30,406	$13,975	$13,975	$22,286	$10,243	$10,243
17	$41,741	$19,185	$19,185	$29,810	$13,701	$13,701	$21,429	$9,849	$9,849
18	$41,741	$19,185	$19,185	$29,225	$13,433	$13,433	$20,605	$9,470	$9,470
19	$41,741	$19,185	$19,185	$28,652	$13,169	$13,169	$19,812	$9,106	$9,106
20	$497,438 or $41,741	$19,185	$19,185	$334,762 or $28,091	$12,911	$12,911	$227,024 or $19,050	$8,756	$8,756
NPV if retire in yr 20	**$1,290,517**	**$861,953**	**$1,156,964**	**$989,197**	**$782,578**	**$1,033,380**	**$775,248**	**$720,589**	**$932,412**
21	$41,741	$19,185	$19,185	$27,540	$12,658	$12,658	$18,317	$8,419	$8,419
22	$41,741	$19,185	$19,185	$27,000	$12,410	$12,410	$17,613	$8,095	$8,095
23	$41,741	$19,185	$19,185	$26,470	$12,166	$12,166	$16,935	$7,784	$7,784
24	$41,741	$19,185	$19,185	$25,951	$11,928	$11,928	$16,284	$7,484	$7,484
25	$41,741	$19,185	$19,185	$25,442	$11,694	$11,694	$15,658	$7,197	$7,197
26	$41,741	$19,185	$19,185	$24,944	$11,465	$11,465	$15,056	$6,920	$6,920
27	$41,741	$19,185	$19,185	$24,454	$11,240	$11,240	$14,476	$6,654	$6,654
28	$41,741	$19,185	$19,185	$23,975	$11,019	$11,019	$13,920	$6,398	$6,398
29	$41,741	$19,185	$19,185	$23,505	$10,803	$10,803	$13,384	$6,152	$6,152
30	$497,438	$19,185	$19,185	$274,621	$10,591	$10,591	$153,369	$5,915	$5,915
NPV if retire in yr 30	**$1,707,927**	**$1,053,803**	**$1,348,814**	**$1,186,428**	**$898,551**	**$1,149,354**	**$862,286**	**$791,606**	**$1,003,429**

[a/] If a producer is retiring in year 8, then add the first number, $497,438, to NPV and exclude the second number, $41,741. If the producer is not retiring in year 8, then exclude the first number, $497,438, and add the second number, $41,741, to NPV. The first number is the value generated when the cow-calf-yearling herd is liquidated in a single year. The second number is the cow-calf-yearling's average annual ROCC if it is not liquidated that year.

[b/] Net present values (NPVs) reported in this table are similar, but not identical, to mean NPVs reported in tables 3 and 4. Values reported in tables 3 and 4 are derived from 10,000 random draws from price distributions within a Monte Carlo simulation. Mean values reported in this appendix do not account for price variability; they are based on a single set of average prices.