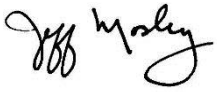
MONTANA STATE UNIVERSITY EXTENSION

MEMORANDUM

TO: Frank McCall
Montana Department of Revenue

Bonnie Hamilton
Montana Department of Revenue

FROM: Jeff Mosley
Professor of Range Science & Extension Range Management Specialist



DATE: July 13, 2014

SUBJECT: Agricultural Property Tax Classification

Per your request, I reviewed calculations currently used by the Montana Department of Revenue (MDR) to estimate: 1) livestock carrying capacity, and 2) the number of Animal Unit Months (AUMs) necessary to generate $1500 in annual gross income.

Livestock Carrying Capacity

There are several ways to estimate a parcel of land's livestock carrying capacity. One way uses a formula that compares livestock forage supply with livestock forage demand. This formula is widely used and accepted within the range management profession, and my understanding is that MDR currently uses this equation. It can be written in the following format:

Number of AUMs/acre = x ÷ ab

Where:
x = amount of palatable forage produced per acre (lbs/acre);
a = factor to adjust for the proportion of forage utilized by livestock; and
b = amount of forage needed per month per Animal Unit (lbs/AUM).

The formula is simple and straightforward, but MDR must make several decisions about the appropriate numerical values to use for *x*, *a*, and *b*.

Appropriate Value for *x*, Amount of Palatable Forage Produced per Acre

My understanding is that MDR currently procures numerical values for *x* from soil survey data supplied by Montana NRCS. Unfortunately, Montana NRCS soil surveys do not directly provide such an estimate. Instead, soil surveys provide the amount of total annual production of aboveground plant biomass, regardless of its palatability. Because some of the biomass is unpalatable, using total plant production values from soil surveys would cause MDR to overestimate livestock carrying capacity.

Department of Animal and Range Sciences

Extension Range Management
213 Animal Bioscience Bldg
PO Box 172900
Bozeman, MT 59717-2900

Tel (406) 994-5601
Fax (406) 994-5589
Email jmosley@montana.edu

Another issue is that the total plant productivity values provided in soil surveys are for parcels in climax (i.e., pristine or near-pristine) ecological condition. Privately owned Montana rangelands, however, are rarely in climax condition, and plant production on Montana privately owned rangelands is usually less than climax. One reason is because the ecological condition that is the most economically and environmentally sustainable for ranching is 40-60% similar to climax, not 100% similar to climax (Dunn et al. 2010). Therefore, using plant productivity values from climax for *x* would cause MDR to calculate stocking rates that are above a ranch's long-term economic optimum and possibly encourage landowners to stock their land above its ecological carrying capacity.

My understanding is that MDR currently recognizes these issues surrounding the use of total plant productivity values for *x*. Accordingly, MDR compensates for differences in forage palatability and departures from climax condition by using soil survey values of *x* that are midway between Normal Years and Unfavorable Years. Unfortunately, when Montana NRCS calculates stocking rates using soil survey data, their calculations incorporate greater compensation for differences in forage palatability and departures from climax condition than MDR. Montana NRCS compensates by using soil survey total plant productivity values from Unfavorable Years which, of course, are less than the values used by MDR. This is one reason why MDR calculates stocking rates that are above those recommended by Montana NRCS. I generally also recommend using the total plant productivity values from Unfavorable Years when I help landowners estimate sustainable stocking rates.

Inconsistent stocking rate calculations among MDR and Montana NRCS cause confusion and frustrations for landowners, especially landowners participating in federal cost-share programs with Montana NRCS. Federal cost-share participants are required to use stocking rates calculated by Montana NRCS, yet MDR currently assesses landowners for stocking rates greater than what Montana NRCS allows and at stocking rates above what Montana NRCS recommends as ecologically and economically sustainable.

Recommendation: MDR should change its calculations to become consistent with Montana NRCS and MSU Extension Range Management. For values of x, MDR should use plant productivity values in soil surveys from Unfavorable Years.

Appropriate Values for *a*, Forage Utilization Factor

Montana state laws and regulations require Montana landowners to provide forage for wildlife. Thus, Montana landowners cannot stock their land with the maximum number of livestock that the land could support without wildlife. My understanding is that current MDR assessments recognize this fact. By using the number '4' for the forage utilization factor *a*, MDR allocates 25% of the available forage to livestock, 25% to wildlife, and 50% to sustaining rangeland health. The value of '4' is similarly used by Montana NRCS to calculate livestock stocking rates. In this way, state and federal government are consistent in their approach and message to landowners which, as mentioned above, resolves many potential problems.

Recommendation: MDR should continue using a forage utilization factor of '4' in its livestock stocking rate calculations.

Appropriate Value for *b*, Amount of Forage per AUM

Opinions vary within the range management profession as to an appropriate value for *b*. The values most commonly used are 780, 790, or 915 lbs/AUM. MSU Extension Range Management usually uses 790 lbs/AUM while Montana NRCS uses 915 lbs/AUM. The three commonly used values are derived by:

780 lbs/AUM = 26 lbs/day × 30 days/month;

790 lbs/AUM = 26 lbs/day × 30.4 days/month; and

915 lbs/AUM = 30 lbs/day × 30.5 days/month.

In these three equations, the number of days/month varies from 30 to 30.4 to 30.5. The value 30.4 has the strongest justification, given that 365 days/year ÷ 12 months/year = 30.4. The value 30 is merely a rounded down version of 30.4 and the value 30.5 is merely a slightly rounded up version of 30.4. MSU Extension Range Management uses 30.4 days/month while Montana NRCS uses 30.5 days/month.

In the three equations above, the number of lbs/day varies from 26 to 30. This number accounts for both forage consumed by livestock and forage lost due to livestock trampling.

While grazing on rangeland and pasture, ruminant livestock usually consume an amount of forage daily (dry matter basis) equivalent to 1 to 3% of their body weight (Holechek 1988). The amount is nearer 1% when ruminant livestock graze low quality forage and nearer 3% when grazing high quality, more digestible forage. Therefore, the amount of forage consumed by one Animal Unit (defined as a 1,000-lb cow or equivalent; SRM 1989) is between 10 and 30 lbs/day. Many people calculate stocking rates using the midpoint of 2% of body weight or 20 lbs/day to reflect average forage quality conditions (Holechek 1988). If forage quality is slightly above average, forage intake could be 2.4% of body weight, or 24 lbs/day. Montana NRCS uses 2.4% of body weight for daily intake.

In addition to the amount of forage consumed by grazing livestock, some forage is lost to trampling. Forage lost to trampling averages 0.6% of an animal's body weight (calculated from Quinn and Hervey 1970), or 6 lbs/day for a 1,000-lb Animal Unit.

Taken together, if forage quality is average, forage intake plus trampling losses would be 2.6% of body weight, or 26 lbs/day for a 1,000-lb Animal Unit. If the forage quality is slightly above average, forage intake plus trampling losses would be 3.0% of body weight, or 30 lbs/day for a 1,000-lb Animal Unit.

Recommendation: MDR could legitimately defend using either 780, 790, or 915 lbs/AUM for b when calculating livestock stocking rates. However, I recommend MDR defer to Montana NRCS and use 915 lbs/AUM. As mentioned above, this consistency is especially important for landowners participating in cost-share programs with Montana NRCS. Using 915 lbs/AUM would also make MDR calculations consistent with Montana NRCS throughout MDR's livestock stocking rate calculations. Consistency in calculations would eliminate the current problem of a landowner being taxed by state government for AUMs that the federal government has told the landowner he/she does not have available to use.

If MDR uses plant productivity values supplied by Montana NRCS soil surveys for x, and MDR uses the same forage utilization factor of '4' used by Montana NRCS, it is difficult for MDR to justify why it would not use the Montana NRCS value of 915 lbs/AUM for b in its calculations. And given that Montana NRCS is recognized by most people to have more knowledge about appropriate livestock stocking rates than MDR, using the Montana NRCS approach throughout makes it simpler and easier for MDR to defend its assessments.

Adjustments for Cow Size

The last complicating factor for MDR when calculating livestock carrying capacity concerns cow size. Montana statute directs MDR to use 1,200 lbs for average cow size beginning in 2015. This directive creates a potential challenge in terminology, given that the range management profession defines one Animal Unit as a 1,000-lb cow or equivalent and an Animal Unit Month is defined as the amount of forage consumed in one month by one, 1,000-lb Animal Unit (SRM 1989). I believe the simplest and best way for MDR to accommodate this legislative directive is for MDR to follow NRCS procedures for calculating sustainable livestock stocking rates and then multiply the result by 0.83 to account for 1200-lb Animal Units versus 1000-lb Animal Units (1000/1200 = 0.83). An alternative is for MDR to accommodate the directive by substituting 1,098 lbs for b in its calculations (3%/day of 1200-lb cow x 30.5 days/month = 1,098 lbs/month). Either way, I strongly suggest that MDR refer to its capacity estimates based on 1200-lb Animal Units as "MDR-adjusted AUMs" or a similar term in order to minimize confusion.

Summary Recommendations for Calculating Livestock Carrying Capacity: 1) for values of x, MDR should use plant productivity values in NRCS soil surveys from Unfavorable Years; 2) for values of a, MDR should continue using a forage utilization factor of '4'; 3) for values of b, MDR should use 915 lbs/AUM; and 4) to adjust for 1200-lb cows, MDR should multiply total estimated AUMs by 0.83 to arrive at its final AUM capacities.

Number of AUMs Necessary to Generate $1500 Gross Income

Per your request, I began by reviewing the spreadsheet developed by Dr. Myles Watts from the Department of Agricultural Economics and Economics at Montana State University. Dr. Watts prepared this spreadsheet for MDR in July 2009. I found that all of Dr. Watts' general assumptions remained reasonable and all of the equations were accurate.

Next, I updated the spreadsheet with cattle prices from 2007-2013, and I limited the management alternatives to ones using 1,200-lb cows. One challenge encountered was that I was unable to use the same data source for prices as Dr. Watts because the USDA National Agricultural Statistics Service (NASS) stopped collecting cow and calf price data after 2010. Fortunately, I was able to acquire similar price data from the USDA Market News Service and the Livestock Marketing Information Center. From 2007-2013 in Montana, the Olympic average for calves was $128.78 and the Olympic average for slaughter cows was $56.08 (Table 1).

Table 1.

Year	Calf Price (cwt)	Cow Price (cwt)
2013	$159.78	$75.61
2012	$160.30	$72.43
2011	$143.60	$65.28
2010	$119.79	$53.96
2009	$103.12	$41.41
2008	$106.96	$45.40
2007	$113.78	$43.32

Spreadsheet results are shown below in Table 2 for 6 alternative management scenarios with 1200-lb cows:

Alternative 1: raise own replacements and account for calf forage consumption
Alternative 2: raise own replacements but do not account for calf forage consumption
Alternative 3: purchase replacements and account for calf forage consumption
Alternative 4: purchase replacements but do not account for calf forage consumption
Alternative 5: purchase bred cows (no bulls or replacements) and account for calf forage consumption
Alternative 6: purchase bred cows (no bulls or replacements) but do not account for calf forage consumption

The Olympic average from the 6 alternatives in Table 2 is 31.38 AUMs. Alternatives 3 and 4 are most typical of small beef cattle operations, and the average for Alternatives 3 and 4 is 31.0 AUMs.

Recommendation: MDR should consider using 31 AUMs as the minimum number of AUMs necessary to generate $1,500 of annual gross income.

Literature Cited

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Quinn, J.A., and D.F. Hervey. 1970. Trampling losses and travel by cattle on sandhill range. *Journal of Range Management* 23:50-55.

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Table 2. Minimum AUMs to Meet Revenue Threshold

Herd Composition, Weight, and Prices	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**	**Alt 5**	**Alt 6**
Cows	1	1	1	1	1	1
Bulls (1 bull per 25 cows)	0.04	0.04	0.04	0.04	0	0
Replacement Heifers (18% replacement rate)	0.18	0.18	0.18	0.18	0	0
Calves Weaned (91% weaning percentage)	0.91	0.91	0.91	0.91	0.91	0.91
Cow Weight (1200 lbs)	1200	1200	1200	1200	1200	1200
Calf Weight (45% of cow weight)	540	540	540	540	540	540
Olympic Average Cow Price (2007-2013)	56.08	56.08	56.08	56.08	56.08	56.08
Olympic Average Calf Price (2007-2013)	128.78	128.78	128.78	128.78	128.78	128.78
Calves Sold (calves weaned - replacements)	0.73	0.73	0.91	0.91	0.91	0.91
Cow Death Loss (1%)	0.01	0.01	0.01	0.01	0.01	0.01
Cows Sold (replacements - cows died)	0.17	0.17	0.17	0.17	0.17	0.17
Animal Unit Months (AUMs)						
Animal Unit Equivalent - Cows	1.2	1.2	1.2	1.2	1.2	1.2
Animal Unit Equivalent - Bulls	1.5	1.5	1.5	1.5	0	0
Animal Unit Equivalent - Replacement Heifers	0.85	0.85	0.85	0.85	0	0
Animal Unit Equivalent - Calves	0.3	0	0.3	0	0.3	0
Cow AUM (cow AUE x 1.0)	1.2	1.2	1.2	1.2	1.2	1.2
Bull AUM (bull AUE x 0.04)	0.06	0.06	0.06	0.06	0	0
Replacement Heifer AUM (replacement heifer AUE x 0.18)	0.15	0.15	0.15	0.15	0	0
Calf AUM (calf AUE x 0.91)	0.27	0	0.27	0	0.27	0
Grazing Months	10	10	10	10	10	10
Total AUMs (sum of cow, bull, heifers, and calf AUMS)	16.8	14.1	16.8	14.1	14.7	12
Revenue						
Calf Revenue (calf weight x calf price x calves sold/100)	507.65	507.65	632.82	632.82	632.82	632.82
Cow Revenue (cow weight x cow price x cows sold/100)	114.4	114.4	114.4	114.4	114.4	114.4
Total Revenue per Cow (calf revenue + cow revenue)	622.05	622.05	747.22	747.22	747.22	747.22
Revenue per AUM (total revenue per cow / total AUMs)	37.03	44.12	44.48	52.99	50.83	62.27
Minimum Revenue Threshold	1500	1500	1500	1500	1500	1500
AUMS Needed (Minimum Revenue/Revenue per AUM)	40.51	34	33.72	28.31	29.51	24.09