

## Lesson Plan 7:

# Stocking Rate Calculations

Grades 6 and up, or for advanced Math students younger than grade 6.

### Basic Principles:

- Each ecosystem hosts a variety of plants and animals that are uniquely suited to that environment.
- Sustainability, or a renewable balance between man and nature, is necessary for a healthy ecosystem.
- Healthy rangelands depend on maintaining the water, soil, plant, and animal resources.
- Active management by ranchers maintains healthy ecosystems.
- Livestock grazing is compatible with wildlife use and recreation.
- The aspects of an ecosystem (soil, water, vegetation, animals, etc.) impact and rely upon each other.

### Fundamental Concepts:

- Selectivity
- Land use / multiple use
- Conservation
- Grazing
- Ranching
- Ecosystems
- Natural resource ecology
- Sustainability
- Erosion
- Monitoring
- Livestock / Wildlife
- Connectivity



### Montana Content Standards Met By This Lesson:

#### End of Grade 4

- Math #1: benchmarks 3 & 4
- Math #3: benchmarks 1 & 3
- Math #6: benchmarks 2 & 3

#### End of Grade 8

- Science #3: benchmark 4
- Math #1: benchmarks 1, 3, & 4
- Math #3: benchmark 1, 2, 4, & 5
- Math #5: benchmarks 3, 5, & 6
- Math #6: benchmarks 2 & 3
- Math #7: benchmark 2

#### Upon Graduation-End of Grade 12

- Math #1: benchmarks 1 & 4
- Math #3: benchmarks 1, 2, 3, & 5
- Math #5: benchmark 3
- Math #7: benchmark 4

### Student Inquiries:

- How do ranchers maintain healthy ecosystems?
- Why do ranchers care about the environment?
- What is a rangeland?
- How do rangelands affect water quality?
- What is grazing?
- Who grazes?
- What do grazers eat?
- How much can grazers eat?
- Where does grazing occur?
- How does grazing affect the ecosystem?
- Do livestock and wildlife graze the same?
- How do livestock and wildlife live in the same ecosystems together?

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- How much grazing can occur each year?
- How long can/have rangelands be(en) grazed?
- How does overgrazing wear out rangeland resources?
- How does ranching benefit wildlife?

### **Instructional Objectives:**

- Students will organize stocking rate data onto a chart.
- Students will identify and differentiate data from the included tables.
- Students will calculate stocking rates.

### **Materials:**

- background information included here
- calculators
- pencil & paper
- formulas and tables included here
- enough copies of the included 3-page worksheet

### **Background Information:**

Rangelands are areas of land with predominantly native vegetation made up of a mix of grasses, forbs (or wildflowers), and shrubs. Rangelands vary in their ability to produce vegetation because of different underlying soil types, amounts of moisture received, and health of the vegetation due to past management practices. Rangelands that have been moderately to lightly grazed, have soils with more organic matter, and which receive more rainfall will have healthier vegetation capable of producing more forage (an amount measured in pounds/acre or kilograms/hectare).

Cattle and sheep are the predominant domestic grazers on Montana's rangelands, but big game wildlife species (such as elk, deer, and antelope) graze these same areas as well. It is important that ranchers manage how many of their animals will graze in each pasture, taking into consideration use by wildlife species, so the rangeland is not over-grazed and the vegetation remains healthy and productive for grazing each successive year. Ranchers manage so that livestock do not consume all of the forage that is available, but use a general rule of thumb to take half and leave half of the forage by weight. By leaving a portion of the forage, the remaining stubble allows those plants to maintain root reserves for survival throughout the winter and slows water movement the following spring, reducing erosion.

Although the total land area may be covered with vegetation, there are some considerations to make regarding whether livestock or wildlife will use certain portions of the land. For cattle, these considerations are slope of the land and distance from water, and for elk these considerations include distance from cover and roads. The value that different types of vegetation have to the diet of cattle and elk (or grazing merit) determines its palatability (tastiness) for each animal. When calculating stocking rate, or the number of animals grazing an area of land for a certain amount of time, consider 100% of the forage available for those plant species with good grazing merit, 50% for those with fair grazing merit, and 0% of the forage weight for those plant species with poor grazing merit.

## Lesson Activities

1) The teacher will need to preview the lesson's information and worksheet.

2) Make enough copies of the worksheet for the students who will be completing this assignment. Although it is actually simpler than it at first seems, the lesson does incorporate some complex mathematical concepts. You may want to only give this lesson to your more advanced Math students, perhaps as a challenging substitute for another assignment. If providing the lesson and worksheets to all students in your class, an introductory lesson on some algebraic concepts may be needed, particularly if the students have not yet had much exposure to Algebra.

3) After students have read the Introduction and Background Information, have them finish filling out Table 1 using information from the introduction.

4) Using the unadjusted stocking rate equation (provided on their worksheet) and the given information, they will determine the proper stocking rate for the pasture for cattle only and elk only, and then fill in Table 2. They will need to calculate the equation twice, once for cattle and once for elk.

5) Students will next take into consideration the spatial variables that will determine whether or not livestock and wildlife will use certain areas of the pasture (Tables 4-7) and calculate the proper adjusted stocking rate for cattle only and elk only, and then fill out Table 3 using the adjusted stocking rate equation.

6) In order to determine how many elk will be able to graze with the cattle (and vice versa) without over grazing the pasture, they will need to calculate a mixed species stocking rate using the SRm equation provided on their worksheet. Once they have calculated the adjusted stocking rate for cattle (or elk), they then take the difference between the unadjusted and adjusted values and multiply by the animal equivalent. For example, if the unadjusted stocking rate for cattle is 100 cows and the adjusted is 60 cows, then the difference, 40 cows, is multiplied by the given value 1.54 elk/1 cow, and we get a mixed species stocking rate of elk to be 61 along with the 60 cows.

### Assessment:

- Correct the included pages of tables using the provided answer key.

### Ascending Levels of Intellectual Demand: (ranchers can be contacted through your local Extension Office)

- Interview a rancher. Develop questions that seek to discover the grazing practices s/he uses, how s/he determines his/her stock rate, and what kind of wildlife use his/her lands.
- Interview three or more ranchers and compare & contrast their grazing practices, stock rate determinations, and the multiple uses of their lands.
- Interview three or more ranchers all from different states and compare & contrast the similarities and differences of grazing practices based on location/geographic region/climate.

### Introduction and Background Information:

Rangelands are areas of land with predominantly native vegetation made up of a mix of grasses, forbs (or wildflowers), and shrubs. Rangelands vary in their ability to produce vegetation because of different underlying soil types, amounts of moisture received, and health of the vegetation due to past management practices. Rangelands that have been moderately to lightly grazed, have soils with more organic matter, and which receive more rainfall will have healthier vegetation capable of producing more forage (an amount measured in pounds/acre or kilograms/hectare).

Cattle and sheep are the predominant domestic grazers on Montana's rangelands, but big game wildlife species (such as elk, deer, and antelope) graze these same areas as well. It is important that ranchers manage how many of their animals will graze in each pasture, taking into consideration use by wildlife species, so the rangeland is not over-grazed and the vegetation remains healthy and productive for grazing each successive year. Ranchers manage so that livestock do not consume all of the forage that is available, but use a general rule of thumb to take half and leave half of the forage by weight. By leaving a portion of the forage, the remaining stubble allows those plants to maintain root reserves for survival throughout the winter and slows water movement the following spring, reducing erosion.

Although the total land area may be covered with vegetation, there are some considerations to make regarding whether livestock or wildlife will use certain portions of the land. For cattle, these considerations are slope of the land and distance from water, and for elk these considerations include distance from cover and roads. The value that different types of vegetation have to the diet of cattle and elk (or grazing merit) determines its palatability (tastiness) for each animal. When calculating stocking rate, or the number of animals grazing an area of land for a certain amount of time, consider 100% of the forage available for those plant species with good grazing merit, 50% for those with fair grazing merit, and 0% of the forage weight for those plant species with poor grazing merit.

### Directions:

1) Finish filling out Table 1 using information from the introduction. Three of them have been done for you as examples.

2) Using the unadjusted stocking rate equation (provided on the next page) and the given information, determine the proper stocking rate (# of animals) for the pasture for cattle only and elk only, and fill in Table 2. You will need to calculate the equation twice, once for cattle and once for elk. Drop all decimals for numbers that represent *animals* (e.g., 6.8 cows becomes 6 cows, and 6.2 cows becomes 6 cows). Round to *tenths* for all other data.

3) Next, take into consideration the spatial variables that will determine whether or not livestock and wildlife will use certain areas of the pasture (Tables 4-7) and calculate the proper adjusted stocking rate for cattle only and elk only, and then fill out Table 3 using the adjusted stocking rate equation.

4) In order to determine how many elk will be able to graze with the cattle (and vice versa) without over grazing the pasture, you will need to calculate a mixed species stocking rate using the SRm equation given below. Once you have calculated the adjusted stocking rate for cattle (or elk), take the difference between the unadjusted and adjusted values and then multiply by the animal equivalent. For example, if the unadjusted stocking rate for cattle is 100 cows and the adjusted is 60 cows, then the difference, 40 cows, is multiplied by the given value 1.54 elk/1 cow, and we get a mixed species stocking rate of elk to be 62 along with the 60 cows.

5) A tip: in order to figure out C, you will first need to figure out D (the number of days from April 1 to November 30).

6) Another tip: the Cattle SRa uses Tables 4 & 5 and the Elk SRa uses Tables 6 & 7

7) Final tip: when reading Tables 4-7, be sure you take the % Use value, not the % Reduction value.

**Given Information:**

- Land area = 1,000 acre pasture (1 acre is approximately the size of a football field)
- Grazing period = 8 months (April through November)
- 50% of palatable forage is usable
- Cattle consume 780 pounds of forage per month
- Elk consume 546 pounds of forage per month
- Animal Equivalents:
  - 1 Elk = 0.65 Cows
  - 1 Cow = 1.54 Elk

Spatial Variables: (use to select the correct information from tables 4-7)

- slope = 6%
- distance from water = 1.8 miles
- distance from ranch road = 0.25 miles
- distance from cover = 0.70 miles

**Formulae:**  $SR_u = \frac{(F)(U)(A)}{(C)(D)}$

- SR<sub>a</sub> = SR<sub>u</sub> X % use for each spatial variable
- SR<sub>m</sub> = (SR<sub>u</sub> – SR<sub>a</sub>) X animal equivalent
- SR<sub>u</sub> = unadjusted stocking rate (number of animals/land area/time period)
- SR<sub>a</sub> = adjusted stocking rate (number of animals/land area/time period)
- SR<sub>m</sub> = mixed species stocking rate
- F = total forage that is palatable (total pounds of all plants/acre = lbs/ac.) (from Table 1)
- U = use allowed (as a % of palatable forage)
- A = area of pasture (acres)
- C = forage consumed per day (pounds)
- D = number of days the pasture will be grazed (days)

Plant Species	Forage available lbs./ac.	Grazing Merit		Palatable Forage	
		Cattle	Elk	Cattle	Elk
Bluebunch wheatgrass	350	Good	Good	350	
Western wheatgrass	300	Good	Good		
Needle and Thread grass	80	Good	Fair		40
Western yarrow	90	Poor	Fair		
Lupine	20	Fair	Good		
Slimflower scurfpea	20	Poor	Poor		0
Snowberry	70	Poor	Fair		
Willow	100	Good	Good		
Rough fescue	400	Good	Good		
Threadleaf sedge	60	Good	Good		
<b>Totals for each column</b>	<b>1490</b>				

**Table 2: Unadjusted Stocking Rates (ignoring spatial variables)**

	Single Specie. Cattle (SRu)	Single Specie. Elk (SRu)	Totals (Cattle SRu + Elk SRu)
# of Cattle	_____	0	_____
# of Elk	0	_____	_____

**Table 3: Adjusted Stocking Rates (taking spatial variables into consideration)**

	Cattle (SRA)	Elk (SRA)	Totals (Cattle SRA + Elk SRA)
Single Specie # of Cattle	_____	0	_____
Single Specie # of Elk	0	_____	_____
Mixed Species Maximum # of Cattle	_____	_____	_____
Mixed Species Maximum # of Elk	_____	_____	_____

**Table 4: Cattle use of landscapes in relation to topography (Holechek et al 1989)**

% Slope	% Use	% Reduction in grazing
0-10	100	None
11-30	70	30
31-60	40	60
>60	0	100 (ungrazable)

**Table 5: Cattle use of landscapes in relation to distance from water (Holechek et al 1989)**

Distance from water (miles)	% Use	% Reduction in grazing
0-1	100	None
1-2	50	50
>2	0	100 (ungrazable)

**Table 6: Elk use of landscapes in relation to distance from cover (Arba 1992)**

Distance from cover (miles)	% Use	% Reduction in grazing
0.0-0.50	100	0
0.51-0.75	75	25
0.76-1.0	50	50
1.1-1.3	25	75
>1.3	0	100

Distance from roads (miles) (depends on road use)			% Use	% Reduction in grazing
State Highway	County Road	Ranch Road		
>0.50	>0.30	>0.12	100	0
0.30-0.50	0.16-0.30	0.10-0.12	50	50
0.0-0.30	0.0-0.16	0.0-0.10	25	75

# Answer Key

Plant Species	Forage available lbs./ac.	Grazing Merit		Palatable Forage	
		Cattle	Elk	Cattle	Elk
Bluebunch wheatgrass	350	Good	Good	350	<b>350</b>
Western wheatgrass	300	Good	Good	<b>300</b>	<b>300</b>
Needle and Thread grass	80	Good	Fair	<b>80</b>	40
Western yarrow	90	Poor	Fair	<b>0</b>	<b>45</b>
Lupine	20	Fair	Good	<b>10</b>	<b>20</b>
Slimflower scurfpea	20	Poor	Poor	<b>0</b>	0
Snowberry	70	Poor	Fair	<b>0</b>	<b>35</b>
Willow	100	Good	Good	<b>100</b>	<b>100</b>
Rough fescue	400	Good	Good	<b>400</b>	<b>400</b>
Threadleaf sedge	60	Good	Good	<b>60</b>	<b>60</b>
<b>Totals for each column</b>	<b>1490</b>			<b>1300</b>	<b>1350</b>

(add columns)

	Single Specie: Cattle (SRu)	Single Specie: Elk (SRu)	Totals (Cattle SRu + Elk SRu)
# of Cattle	<b>104</b>	0	<b>104</b>
# of Elk	0	<b>154</b>	<b>154</b>

$$\frac{1300 \times .5 \times 1000}{25.6 \times 244}$$

$$\frac{1350 \times .5 \times 1000}{17.9 \times 244}$$

$$104 + 0$$

$$0 + 154$$

1300 is from Table 1  
 .5 is 50% palatable value  
 1000 is number of acres  
 244 is number of days from Apr. 1 to Nov. 30  
 25.6 lbs./day = 780 lbs. per month x 8 months  
 244 days

1350 is from Table 1  
 .5 is 50% palatable value  
 1000 is number of acres  
 244 is number of days from Apr. 1 to Nov. 30  
 17.9 lbs./day = 546 lbs. per month x 8 months  
 244 days

**Table 3: Adjusted Stocking Rates (taking spatial variables into consideration)**

	# of Cattle	# of Elk	Totals (# of Cattle + # of Elk)
Single Species (SRa) # of Cattle	<b>52</b>	0	<b>52</b>
Single Species (SRa) # of Elk	0	<b>115</b>	<b>115</b>
Mixed Species (SRm) Maximum # of Cattle	<b>52</b>	<b>80</b>	<b>132</b>
Mixed Species (SRm) Maximum # of Elk	<b>25</b>	<b>115</b>	<b>140</b>

52 = 104 x 1 x 1/2	104 is Cattle SRa, 1 is 100% use for 6% slope, 1/2 is 50% use for distance from water
115 = 154 x .75 x 1	154 is Elk SRa, .75 is 75% use for distance from cover, 1 is 100% use for distance from roads
80 = (104 - 52) x 1.54	104 is Cattle SRa, 52 is Cattle SRa, 1.54 is Elk equivalent, 80 represents number of Cattle
25 = (154 - 115) x 0.65	154 is Elk SRa, 115 is Elk SRa, 0.65 is Cattle equivalent, 25 represents number of Elk
132 = 52 cows + 80 elk	132 is Cattle SRa (i.e. 52) plus additional elk grazing using the SRa's equivalent (i.e. 80)
140 = 25 cows + 115 elk	140 is Elk SRa (i.e. 115) plus additional cattle grazing using the SRa's equivalent (i.e. 25)