CONTESTANT NO._____

2015 UNDERGRADUATE RANGE MANAGEMENT Mini-EXAM

Society for Range Management

Instructions

This examination consists of 52 multiple choice questions. Choose the one best answer for each question and fill in the appropriate circle on the scantron answer sheet provided.

Put your assigned contestant number on this examination booklet. Put your name and contestant number on the scantron answer sheet.

Length of Testing Period

60 Minutes

Grading

The entire examination is worth 150 points.

I. RANGE ECOLOGY (30 points)

1. Globally, rangelands occupy about _____% of the earth's land area.
   a. 10
   b. 25
   c. 50
   d. 95

For question 2, please use the following table (Ansley et al. 2014 REM)

Table 3. Mesquite and grass root mass density (0–270 cm depth), mesquite root mass · tree^{-1}, mesquite aboveground mass · tree^{-1}, and mesquite R:S mass ratio in each treatment (Mean ± SE; $n=3$). We used the same soil volume for trees in the Natural treatment as with the containerized trees. Means within a row with similar letters are not different at $P \leq 0.05$.

	Treatment			
Variable	Irrigated	Rainout	Control	Natural
Mesquite fine root mass density (g · m^{-2})	128.0 ± 3.8 a	87.4 ± 21.1 ab	66.5 ± 13.8 b	51.4 ± 2.1 b
Mesquite coarse root mass density (g · m^{-2})	93.1 ± 19.7 b	657.7 ± 197.4 a	219.7 ± 39.3 b	207.1 ± 86.7 b
Mesquite total root mass density (g · m^{-2})	221.1 ± 22.4 b	745.1 ± 214.5 a	286.2 ± 53.0 b	258.5 ± 85.6 b
Grass root mass density (g · m^{-2})	309.7 ± 48.7 a	117.6 ± 24.7 b	303.9 ± 20.3 a	325.4 ± 58.5 a
Mesquite + grass root mass density (g · m^{-2})	530.8 ± 54.0 a	862.6 ± 201.1 a	590.1 ± 72.5 a	583.8 ± 137.4 a
Mesquite fine + coarse root mass · tree^{-1} (kg)[1]	9.4 ± 0.9 b	31.6 ± 9.1 a	12.1 ± 2.2 b	11.0 ± 3.6 b
Mesquite aboveground mass · tree^{-1} (kg)	47.6 ± 1.2 a	34.7 ± 1.9 a	40.1 ± 8.5 a	39.6 ± 10.4 a
Mesquite R:S mass ratio	0.20 ± 0.02 b	0.91 ± 0.27 a	0.32 ± 0.08 b	0.27 ± 0.03 b

[1]Root mass tree^{-1} (kg) = [root mass density (g · m^{-2})] × [surface area of container (42.4 m^2)]/1 000.

2. (**4pts**) Increasing frequency of drought (per results of the rainout treatment compared to control plots) would be predicted to:
   a. influence aboveground mass of mesquite but not belowground mass, per tree.
   b. influence the amount and magnitude of change in coarse root density more than fine root mass density for mesquite.
   c. increase allocation of carbon to aboveground mass proportionally more than to belowground mass for mesquite.
   d. increase grass root mass density but not affect mesquite total root mass density.

For question 3, please use the following table (Dufek et al. 2014 REM)

Table 1. Least squares means ± standard error definition (SEc) for purple threeawn samples collected at different phenological stages 1 yr posttreatment in 2011 and 2012. ($n=54$).

	Phenological stage						
Measurement[1]	Vegetative	Boot	Flowering	Maturity	Senescence	SEc	*P* value
NE_m (Mcal · kg^{-1})	1.14 a[2]	1.08 b	1.06 b	1.03 c	1.00 c	0.01	< 0.01
TDN (% DM)	53.89 a	51.65 b	51.01 b	49.67 c	48.52 c	0.61	< 0.01
ADF (% DM)	42.67 c	44.64 b	45.20 b	46.38 a	47.37 a	0.54	< 0.01
Silica (% DM)	5.2 bc	5.8 a	4.9 c	5.1 c	5.6 ab	0.2	< 0.01
AGP (mL · g^{-1} OM)	67.0 a	65.7 a	61.9 bc	62.8 b	60.3 c	0.8	< 0.01
Lag (h)	2.13 a	1.50 c	1.33 c	0.68 d	1.90 b	0.10	< 0.01
IVOMD (% OM)	59.5 bc	68.8 a	61.1 b	58.8 c	47.4 d	0.9	< 0.01

[1]NE_m indicates net energy for maintenance; SEc, standard error of the comparison; TDN, total digestible nutrients; DM, dry matter; ADF, acid detergent fiber; AGP, asymptotic gas production; OM, organic matter; Lag, lag time; and IVOMD, in vitro organic matter disappearance.
[2]Means within rows with a common letter do not differ ($P > 0.05$).

3. **(4pts)** As phenological stage of this grass advances:
   a. net energy, but not total digestible nutrients, decreases.
   b. total digestible nutrients, but not net energy, decreases.
   c. acid detergent fiber, but not total digestible nutrients, increases.

4. Plant communities in mesic and arid systems are primarily constrained by _____ and _____ resources, respectively.
   a. aboveground, belowground
   b. belowground, aboveground
   c. soil water, light

5. Increasing atmospheric carbon dioxide (CO_2) affects semiarid plant communities by:
   a. increasing plant water use efficiency.
   b. reducing forage quality.
   c. increasing competitiveness of plants with deeper root systems.
   d. all of the above
   e. none of the above

6. C3 photosynthesis differs from C4 photosynthesis by:
   a. C3 plants initially fix malate and aspartate for transport to bundle sheath cells.
   b. leaves of C3 plants are comprised of higher amounts of bundle-sheath cells.
   c. CO_2 compensation point is lower for C3 plants than C4 plants.
   d. all of the above
   e. none of the above

7. The least mature tissue of a leaf blade is located:
   a. at the tip of the leaf.
   b. at the mid-portion of the leaf.
   c. at the base of the leaf.

8. Plant ecophysiology is the study of:
   a. physiological function of individual plants in their environment.
   b. ecophysiological processes influencing size and distribution of populations.
   c. biochemical processes influencing the structure and function of groups of plants.
   d. ecological processes influencing the productivity and nutrient cycling of systems.

9. Which of the following statements is correct regarding ecological processes?
   a. Energy cycles and nutrients flow in semiarid rangelands.
   b. Energy cycles and nutrients cycle in mesic rangelands.
   c. Energy flows and nutrients flow in mesic rangelands.
   d. Energy flows and nutrients cycle in semiarid rangelands.

10. How much usable solar radiation available to range plants is NOT utilized in photosynthesis?
    a. <1%
    b. 5-10%
    c. 60-70%
    d. 99%

11. Which of the following statements regarding the rate of substrate decomposition is correct?
    a. Decomposition is generally more rapid for substrates with a high carbon:nitrogen ratio.
    b. Decomposition is generally less rapid for substrates with a high lignin:nitrogen ratio.
    c. The carbon:nitrogen ratio is a better predictor of the rate of substrate decomposition than is the lignin:nitrogen ratio.
    d. None of the above

12. Which of the following statements concerning root turnover is correct?
    a. Average turnover rates are higher for coarse than fine roots.
    b. Root turnover decreases from the tropical to high-latitude systems.
    c. Root turnover rates decrease with increases in mean annual temperature.
    d. The highest average turnover rates occur in tree root systems.

13. Rubisco is best defined as:
    a. the first stable product of the C_3 pathway.
    b. an enzyme that attaches CO_2 to RUBP.
    c. an enzyme that attaches CO_2 to PEP.
    d. none of the above

II. GRAZING MANAGEMENT (26 points)

14. Which of the following is a plant trait enabling rapid regrowth following a grazing event?
    a. Flexible allocation priorities
    b. Intrinsically low rates of leaf turnover
    c. Elevated meristems
    d. All of the above
    e. None of the above

15. Which of the following is a difference between vertebrate and invertebrate herbivory?
    a. Rate of damage to plant
    b. Tissue specificity
    c. Distribution of damage to plant
    d. All of the above
    e. None of the above

16. Which of the following statements concerning retention time in the rumen is correct?
    a. Retention time in the rumen decreases with increases in plant morphological development.
    b. Retention time in the rumen depends mainly on the degradation rate of the degradable fraction of the forage.
    c. Retention time in the rumen decreases with increased particle size of the forage.
    d. Retention time in the rumen increases with a decrease in the amount of cell walls in the forage.

17. A diverse array of biochemical compounds referred to as secondary compounds contribute to:
    a. grazing tolerance-physiological mechanisms.
    b. grazing avoidance-biochemical mechanisms.
    c. grazing tolerance-morphological mechanisms.
    d. none of the above

18. The amount of nonprotein nitrogen incorporated into protein by rumen microorganisms depends primarily on which of the following?
    a. energy
    b. lactic acid
    c. true protein
    d. ammonia

19. The gestation length for cattle is _____ days.
    a. 21
    b. 60
    c. 80
    d. 283
    e. 365

For question 20, please use the following table (Bylo et al. 2014 REM)

Table 1. Effects of grazing intensity, measured at the 20 m×50 m plot scale using dung pat counts, and at the 296-ha pasture scale using stocking rate (animal unit months (AUM) per hectare), and grazing duration on the abundance of ground squirrel burrows and occurrence of American badger burrows in upland and lowland mixed-grass prairie habitats in the grazing experiment located in the Biodiversity and Grazing Management Area in Grasslands National Park of Canada, Saskatchewan, 2006–2012 (excluding 2008). Parameter estimates (β) are followed by upper and lower 95% confidence limits in parentheses.

			American badger		Ground squirrel	
Scale	Position	Variable	β	*P*	β	*P*
Plot	Lowland	Grazing intensity (dung pats · plot^{-1})	0.007 (−0.007 to 0.021)	0.309	0.002 (−0.004 to 0.008)	0.494
		Duration (yr)	0.329 (0.150–0.508)	< 0.001	−0.279 (−0.390 to −0.168)	< 0.001
	Upland	Grazing intensity (dung pats · plot^{-1})	−0.004 (−0.012 to 0.004)	0.372	0.009 (0.003–0.015)	0.002
		Duration (yr)	0.216 (0.083–0.350)	0.002	−0.416 (−0.509 to −0.322)	< 0.001
Pasture	Lowland	Stocking rate (AUM · ha^{-1})	0.193 (−1.056 to 1.441)	0.761	0.179 (−0.374 to 0.732)	0.524
		Duration (yr)	0.362 (0.163–0.560)	< 0.001	−0.281 (−0.405 to −0.158)	< 0.001
	Upland	Stocking rate (AUM · ha^{-1})	−0.886 (−1.618 to −0.153)	0.018	0.822 (0.238–1.406)	0.006
		Duration (yr)	0.279 (0.101–0.457)	0.002	−0.448 (−0.581 to −0.315)	< 0.001

20. **(4pts)** Which of the following is correct regarding scale?
    a. Stocking rate influences both American badgers and ground squirrels in the upland position at the pasture scale, as does grazing intensity for both species in the same landscape position at the plot scale.
    b. Stocking rate does not influence either American badgers or ground squirrels in the lowland position at the pasture scale, nor does grazing intensity influence both species in the same landscape position at the plot scale.
    c. Duration has differential effects on American badgers between scales for both the upland and lowland landscape positons.
    d. Duration has differential effects on ground squirrels between scales for both the upland and lowland landscape positons.

21. **(4pts)** The Been There – Done That ranch is wanting to increase stocking rates on pastures they lease during the grazing season by 20% in 2015 as vegetation conditions have improved following drought in prior years. Last year, they grazed 350 yearling steers (0.7 AUE) on the leased pastures from June 15 to October 1. Which of the following scenarios would increase stocking rates by 20%?
    a. Graze the 350 yearlings and add 35 cows (AUE 1.4) for the same grazing duration as in the prior year
    b. Graze 147 cows (AUE 1.4) from May 31 to November 1
    c. Graze 572 replacement heifers (AUE 0.6) for 90 days
    d. All of the above
    e. None of the above

For question 22, please use the following table (Bohnert et al. 2014 REM)

Table 3. Effects of alfalfa and Russian knapweed supplementation of low-quality, hard fescue straw offered to midgestation beef cows.

	Treatment[1]				*P* value	
Item	Control	Alfalfa	Knapweed	SEM[2]	Control vs. Supplemented	Alfalfa vs. Knapweed
Initial wt., kg	500	512	506	8.8	0.41	0.70
Final wt., kg	481	555	548	5.9	<0.001	0.47
Wt. change, kg	−19	43	42	6.28	<0.001	0.87
Initial BCS[3]	5.3	5.3	5.4	0.06	0.72	0.74
Final BCS	4.2	5.6	5.6	0.81	<0.001	0.47
BCS change	−1.1	0.3	0.2	0.07	<0.001	0.28
Hard fescue straw offered, kg · d^{-1}	10.2	11.0	9.8	0.32	0.60	0.03
Alfalfa or knapweed offered, kg · d^{-1}	0.00	2.27	3.42			
Total DM[3] offered, kg · d^{-1}	10.2	13.3	13.2	0.32	<0.001	0.79

[1]Control = hard fescue straw provided ad libitum; Alfalfa = Control + 2.27 kg · d^{-1} alfalfa; Knapweed = Control + 3.42 kg · d^{-1} Russian knapweed. All hard fescue straw, alfalfa, and Russian knapweed values are expressed as average daily DM · cow^{-1}.
[2]SEM indicates standard error of the mean, $n = 4$.
[3]BCS indicates body condition score; DM, dry matter.

22. **(4 pts)** Type of supplement added to diets of midgestation beef cows:
    a. differed in response of change of body condition scores of cows.
    b. differed in response of final weights of cows.
    c. differed in response of weight change of cows.
    d. all of the above
    e. none of the above

23. Which species of cattle are typically more common in tropical environments?
    a. *Bos taurus*
    b. *Bos indicus*
    c. *Ovis aries*
    d. *Capra hircus*

IIa. GRAZING MANAGEMENT PROBLEM (5 points) – See END OF TEST

III. RANGE IMPROVEMENT (24 points)

24. Which is correct regarding the calculation of a benefit-cost ratio?
    a. Present value of project benefits is divided by future value of project costs.
    b. Present value of project benefits divided by the present value of project costs.
    c. Future value of project benefits is divided by the present value of project costs.

25. Which of the following statements is most correct regarding the efficiency of vegetation filter strips to filter sediment?
    a. There is a positive relationship between efficiency and length of filter strip.
    b. There is a negative relationship between efficiency and slope.
    c. There is a positive relationship between efficiency and vegetation cover.
    d. All of the above
    e. None of the above

For question 26, please use the following table (Dufek et al. 2014 REM)

Table 2. Least squares means ± standard error definition (SEc) for purple threeawn samples collected throughout the growing season from two sites 1 yr following fire treatments ($n=54$).

	Burn treatment				
Measurement[1]	No fire	Summer fire	Fall fire	SEc	*P* value
NE_m (Mcal · kg^{-1})	0.97 c[2]	1.09 b	1.12 a	0.01	< 0.01
TDN (% DM)	47.50 c	52.02 b	53.34 a	0.47	< 0.01
ADF (% DM)	48.28 a	44.32 b	43.16 c	0.41	< 0.01
Silica (% DM)	7.0 a	4.7 b	4.3 c	0.2	< 0.01
AGP (mL · g^{-1} OM)	57.7 b	66.4 a	66.5 a	0.6	< 0.01
Lag (h)	1.84 a	1.36 b	1.33 b	0.08	< 0.01
IVOMD (% OM)	53.6 b	62.3 a	61.4 a	0.9	< 0.01

[1]NEm indicates net energy for maintenance; TDN, total digestible nutrients; SEc, standard error of the comparison; DM, dry matter; ADF, acid detergent fiber; AGP, asymptotic gas production; OM, organic matter; Lag, lag time; and IVOMD, in vitro organic matter disappearance.
[2]Means within rows with a common letter do not differ ($P > 0.05$).

26. (**4 pts**) Responses of purple threeawn to fire include:
    a. increases in in vitro organic matter disappearance irrespective of season of burning.
    b. increases in acid detergent fiber irrespective of season of burning.
    c. decreases in total digestible nutrients irrespective of season of burning.
    d. increases in silica irrespective of season of burning.

27. (**4 pts**) A tractor mounted sprayer outputs 2100 liters/hr, the operator drives the sprayer at 8.8 km/hr, and the desired application rate is 120 liters/ha. What is the spray width?
    a. 20 cm
    b. 200 cm
    c. 20 m
    d. 200 m

For question 28, please use the following table (Bristow et al. 2014 REM)

Table 2. Mean number of trees established per hectare per year following chaining ($n=4$ in "Chaining" column) and prescribed fire ($n=5$ in "Fire" column) treatments. Standard errors (SE), mean difference between treatment types, and *P*-values from fixed-effects analysis of variance comparing means of the two treatment types are also shown.

Tree species	Chaining (mean trees · ha $^{-1}$ · yr $^{-1}$ ± SE)	Fire (mean trees · ha $^{-1}$ · yr $^{-1}$ ± SE)	Difference	*P* value
Combined	5.86 ± 1.56	2.06 ± 0.77	3.81	0.05
Pinyon	3.90 ± 1.21	0.62 ± 0.29	3.29	0.02
Juniper	1.96 ± 0.47	1.44 ± 0.57	0.52	0.52

28. **(4 pts**) Which of the following statements is correct regarding tree establishment?
    a. Establishment of Juniper differs between fire and chaining treatments.
    b. Establishment of Pinyon is similar between chaining and fire treatments.
    c. Differences in tree establishment for the combined species between treatments are attributable to treatment effects on Pinyon only.
    d. All of the above
    e. None of the above

29. Which of the following economic analyses is most commonly used in range improvement projects?
    a. market value
    b. cost-share
    c. benefit-cost
    d. none of the above

30. Discounting:
    a. is the process of paying initial costs plus subsequent interest costs over a repayment period.
    b. is the process of determining the present value of future returns.
    c. is the average percent of the initial investment that must be added to the project cost to account for the probability of project failure.
    d. none of the above

31. **(4 pts**) Seed source A costs $1.17 per kg PLS and is 80% PLS. Seed source B costs $1.45 per kg PLS and is 87% PLS. Herbicide 1 has 550 grams per liter of active ingredient and costs $18.40 per liter. Herbicide 2 has 400 grams per liter active ingredient and costs $15.75 per liter. Based solely on cost, which seed source and herbicide would you recommend for a land owner?
    a. Seed source A and Herbicide 1
    b. Seed source A and Herbicide 2
    c. Seed source B and Herbicide 1
    d. Seed source B and Herbicide 2

IIIa. RANGE IMPROVEMENT PROBLEM (5 points) - SEE END OF TEST

IV. RANGE REGIONS (16 points)

32. California Annual Grassland has _____ grazing resistance and _____ dominated precipitation.
    a. moderate, summer
    b. high, spring
    c. moderate, winter
    d. low, summer

33. Alpine Tundra has _____ grazing resistance and vegetation is _____.
    a. high, tree dominated
    b. low, shrub dominated
    c. low, C3 grass dominated
    d. low, C4 grass dominated

34. The most common type of woody plant in tundra regions is:
    a. *Pinus* spp.
    b. *Salix* spp.
    c. *Acrostaphylos* spp.
    d. *Abies* spp.

35. Which of the following is the correct difference between the physiognomy of the hot desert and the desert grassland?
    a. There are more species of grasses in the desert grassland.
    b. There are more C3 grasses in the desert grassland then in the hot desert.
    c. Grasses in the desert grassland transpire more rapidly than grasses in the hot desert.
    d. All of the above
    e. None of the above

36. Which of the following is the order of shortest to longest for natural fire return intervals?
    a. Sonoran desert, ponderosa pine, tallgrass prairie
    b. Tallgrass prairie, ponderosa pine, Sonoran desert
    c. Ponderosa pine, tallgrass prairie, Sonoran desert
    d. Ponderosa pine, Sonoran desert, tallgrass prairie

37. Which of the desert regions receives the largest percentage of summer precipitation?
    a. Cold desert
    b. Mojave desert
    c. Sonoran desert
    d. Chihuahuan desert

38. Which of the following is the order of size (largest to smallest) of the hot deserts?
    a. Mojave, Chihuahuan, Sonoran
    b. Chihuahuan, Sonoran, Mojave
    c. Sonoran, Mojave, Chihuahuan
    d. Mojave, Sonoran, Chihuahuan

39. Which statement is most correct regarding the relationship between temperature and annual rainfall on range regions?
    a. Spruce-fir forests and deciduous forests exist in areas with similar annual rainfall, but deciduous forests are found in areas with cooler temperatures than spruce-fir forests.
    b. As rainfall increases in temperate areas, spruce-fir forests replace grasslands.
    c. As rainfall increases in cool areas, deciduous forests replace grasslands.
    d. All of the above
    e. None of the above

V. RANGE INVENTORY AND ANALYSIS (20 points)

40. Which of the following is a rationale for using visual obstruction to monitor standing crop and vegetation height-density on rangelands?
    a. Simplicity of the technique.
    b. Dual measurements are obtained (vegetation dry weight for livestock production and height-density for wildlife habitat status).
    c. Application over broad areas with less effort than standard techniques
    d. All of the above
    e. None of the above

For questions 41 and 42, please use the following figure (Scasta et al. 2014 REM)

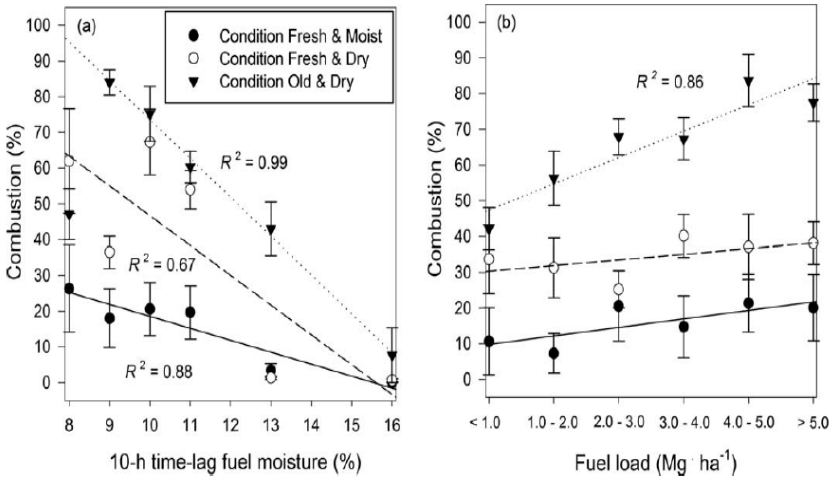

Figure 1. Combustion (mean ± SE) of fecal pats as a function of (**a**) 10-h time-lag fuel moisture and (**b**) fuel load and as a function of a fecal pat condition score index. Coefficients of determination (R^2) are noted for lines with a significant slope ($P < 0.05$).

41. **(4 pts)** Combustion of fecal pats:
    a. decreases with decreasing 10 hour time lag fuel moisture % for fresh and dry pats.
    b. increases with increasing 10 hour time lag fuel moisture % for old and dry pats.
    c. exhibits the strongest relationship with 10 hour time lag fuel moisture when pats are old and dry.

42. **(4 pts)** Fuel load:
    a. significantly influences combustion of fresh and dry fecal pats.
    b. significantly influences combustion of fresh and moist fecal pats.
    c. significantly influences combustion of old and dry fecal pats.

For questions 43 and 44, please use the following figure (Chambers et al. 2014 REM)

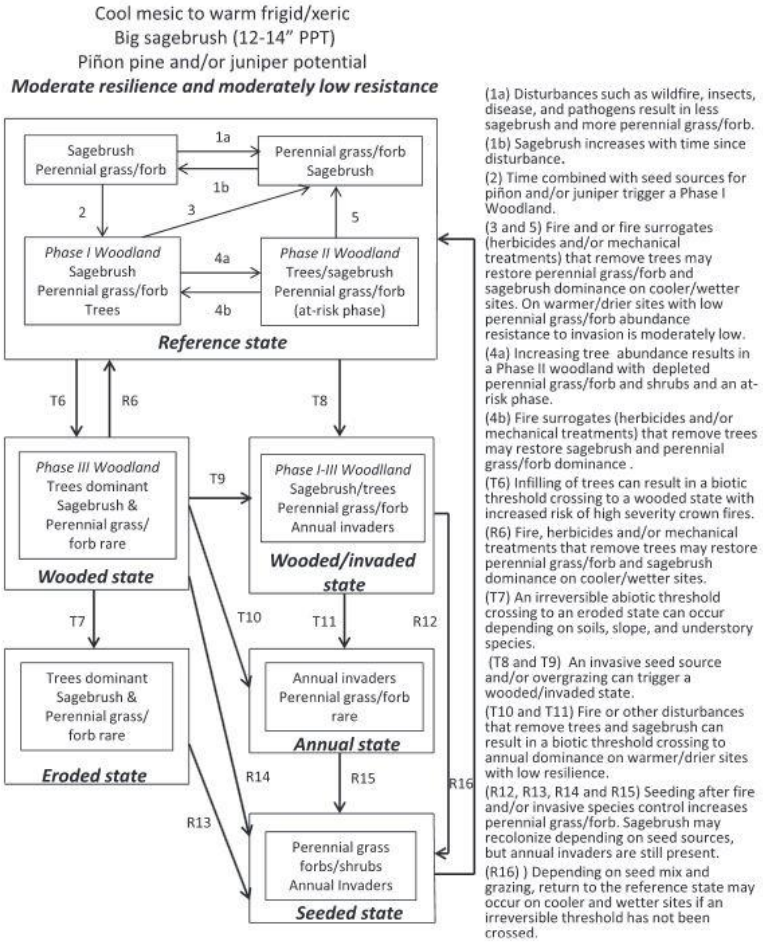

Figure 9. A state and transition model for a big sagebrush ecosystem with a cool mesic to warm frigid/xeric soil temperature/moisture regime that is exhibiting piñon and juniper expansion. This type is characterized by moderate resilience to disturbance and management treatments and moderately low resistance to cheatgrass and other annual exotics. Large boxes illustrate states that are comprised of community phases (smaller boxes) which interact with the environment to produce a characteristic composition of plant species, functional and structural groups, soil functions, and range of variability. Transitions among states are shown with arrows starting with T; restoration pathways are shown with arrows starting with R. The "at risk" community phase is most vulnerable to transition to an alternative state.

43. **(4 pts**) Regarding this state and transition model:
    a. the sagebrush and perennial grass/forb community is the best.
    b. it may be possible for a seeded state community to transition to a reference state community, but only with high inputs and the right conditions.
    c. managers can keep the community in the reference state as long as they never let it transition into an at-risk Phase II Woodland.
    d. a community in the eroded state is very likely to be invaded by cheatgrass or other invasive annuals.

44. **(4 pts**) Regarding this ecological site's resistance and resilience:
    a. this ecological site is better able to withstand entry of invasive annuals than to tolerate disturbance.
    b. both resilience and resistance are moderate.
    c. this ecological site is very resistant to conifer encroachment.
    d. this ecological site is better able to tolerate disturbance than to withstand entry of invasive annuals.

45. Species in rangeland communities can be categorized into plant functional groups based on:
    a. suites of morphological characteristics.
    b. suites of physiological characteristics.
    c. similarities in growth form and seasonality of growth.
    d. all of the above
    e. none of the above

Va. RANGE INVENTORY AND ANALYSIS PROBLEM (10 points) - SEE END OF TEST

VI. MULTIPLE USE RELATIONSHIPS (14 points)

46. Which of the following statements regarding the detrimental effects of grazing animals on trees is correct?
    a. Hardwoods are damaged more by sheep than cattle.
    b. Conifers are damaged less by cattle than sheep.
    c. Older trees are generally more susceptible than young seedlings.
    d. All of the above
    e. None of the above

For question 47, please use the following table (Buchanan et al. 2014 REM)

Table 3. Response ratios and 95% confidence limits comparing the magnitude of coefficients during development to predevelopment for each predictive variable during the summer and winter seasons within the Fortification Creek Area of northeastern Wyoming. A value greater than 1 suggests increased elk use, a value less than 1 suggests decreased use, and a value of 1 represents no change in coefficient magnitude during development in comparison to before development.[1]

Variable	Response ratio	95% LL	95% UL
Summer			
Juniper (%)	1.31	1.26	1.35
North-facing sagebrush (%)	0.78	0.76	0.81
Distance to road	5.73	5.52	5.95
Winter			
Juniper (%)	0.22	0.18	0.26
VRM	1.81	0.27	3.35
Slope	0.59	0.24	0.93
Viewshed	0.80	0.17	1.43
Distance to road	118.71	−39.43	276.82

[1]LL indicates lower confidence limit; UL, upper confidence limit; and VRM, vector ruggedness measure.

47. (**4 pts**) During development, elk selected areas:
    a. with greater juniper cover in summer but not winter.
    b. that were farther from roads in summer but not winter.
    c. with greater cover of sagebrush on north-facing slopes in summer.
    d. with increasing slope in winter.

For question 48, please use the following figure (Augustine et al. 2014 REM)

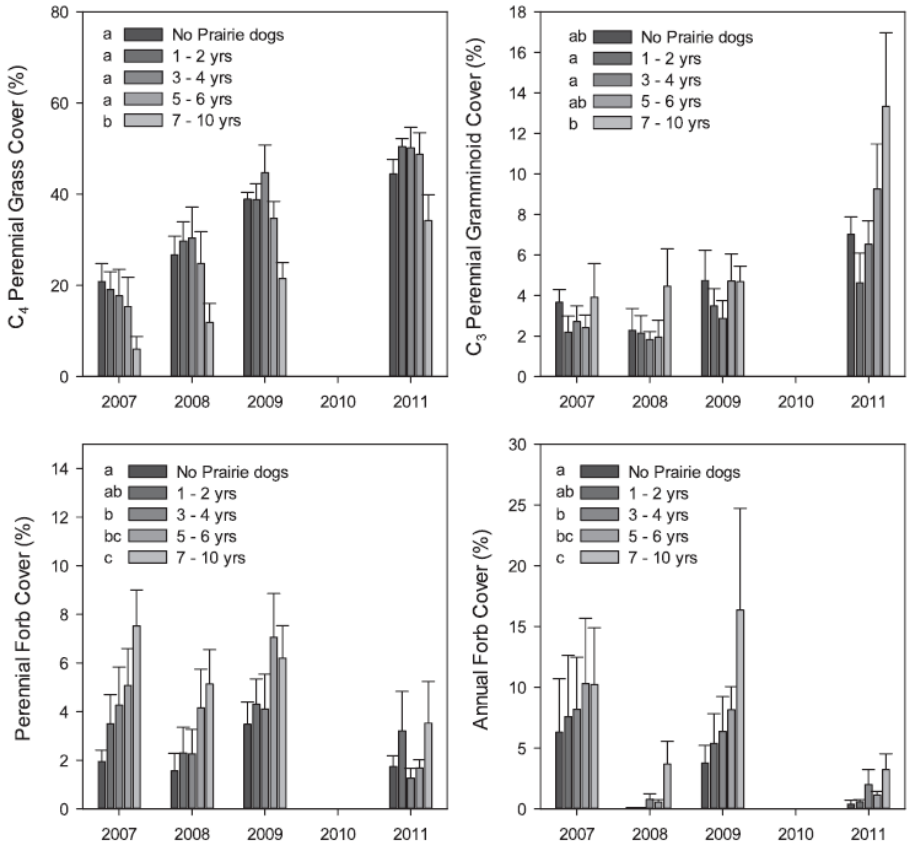

Figure 2. Cover of four plant functional groups in relation to prairie dog occupancy history in the shortgrass steppe of northeastern Colorado during 2007–2011. Bars with different shades refer to sites with varying number of years of prairie dog occupancy prior to a plague epizootic that removed prairie dogs before the 2007 growing season. The label "1–2 years" refers to sites occupied by prairie dogs for 1–2 yr prior to 2007 and so on. For all four plant functional groups, we did not detect significant interactions between prairie dog occupancy history and year (Table 1). Letters next to occupancy category legends and below years indicate which categories and years differ significantly at the $P < 0.05$ level.

48. (**4 pts**) C4 perennial grass cover:
    a. was consistently greater without prairie dogs compared to areas that had less than five years of prairie dog occupancy history.
    b. was significantly less with prairie dog occupancy history compared to areas without prairie dogs when the occupancy time was greater than 6 years.
    c. exhibited a decline across treatments from 2007 to 2011.
    d. all of the above
    e. none of the above

For question 49, please use the following table (Gordon et al. 2014 REM)

Table 3. Mean level of agreement that specific processes or conditions pose a threat to rangelands, 2006 and 2010. Paired *t* tests of a Likert-type measure, 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree ("don't know" responses excluded).

Threat	2006 Mean	2010 Mean	*t*	*P*	Effect size (*d*)[1]
Invasive plants	3.38	3.38	0.151	NS[2]	0.01
Development	3.08	2.91	−4.638	≤0.01	0.20
OHV impacts	2.97	2.87	−3.382	≤0.01	0.11
Riparian impacts	2.92	2.84	−2.241	0.025	0.09
Juniper encroachment	2.66	2.81	3.213	≤0.01	0.16
Overgrazing	2.77	2.81	0.994	NS	0.04
Wildfire	2.85	2.77	−2.072	0.04	0.09
Wild horse overpopulation	2.57	2.74	4.517	≤0.01	0.18
Overly dense sagebrush	2.37	2.50	3.379	≤0.01	0.15

[1]Effect size is a measure of the strength of a relationship between two variables, and can be used to determine practical significance, or which statistically significant relationships are of greatest importance. Vaske (2008) suggests a Cohen's *d* value of 0.2 suggests a minimal relationship, 0.5 a typical relationship, and 0.8 a substantial relationship.
[2]NS indicates not significant; OHV, off-highway vehicle.

49. (**4 pts**) Which of the following groups of processes or conditions were perceived to increase as a threat to rangelands from 2006 to 2010?
    a. Invasive plants, overgrazing and wild horse overpopulation
    b. Overgazing, wildfire, and overly dense sagebrush
    c. Juniper encroachment, wild horse overpopulation and overly dense sagebrush
    d. Riparian impacts and wildfire

GRAZING MANAGEMENT PROBLEM (5 points)

For the past several years, the On the Outskirts of Town ranch has contemplated selling their native shortgrass rangeland to the east of Fort Collins, Colorado for subdividing into ranchettes. The owners of the ranch have been running 40 yearling steers (0.75 AUE) on each of their 259 ha pastures from May 15 to October 1, with gains of 0.95 kg/steer/day. The City Council for Fort Collins and County Commissioners for Larimer County are asking you as the selected consultant to determine the minimum land area needed to support two horses (1.4 AUE) year round on this rangeland, grazing at the same stocking rate as the ranchers have in the past, in order to assist them with covenants for the land if it becomes subdivided.

50. **(5 pts)** What is the minimum land area needed to support the two horses annually?
    a. 26 ha
    b. 33 ha
    c. 53 ha
    d. 65 ha

RANGE IMPROVEMENTS PROBLEM (5 points)

After purchasing the Lots of Sand ranch in Nebraska, your old college friend asks your advice on a 1,000 ha pasture on the ranch where he grazes yearling steers (0.75 AUE) from April 30 to September 1, at a stocking rate of 0.6 AUM/ha. A noxious weed is widespread throughout this pasture, but it noticeably occurs at a high density on a 120 ha parcel within this pasture. You clip plots throughout the pasture, as well as in the area with the highest density of the noxious weed, and in an adjacent pasture that has similar soils and topographic similarity, but without a presence of the noxious weed. After drying these clippings to a constant weight, your back-of-the-envelope calculations are that desirable perennial grasses are producing 180 g/0.10 m^2 in the pasture without the noxious weed. In the pasture with the noxious weed, the production value is 8% lower for the desirable perennial grasses throughout the pasture, and 32% lower in the area with the high density of the noxious weed compared to the pasture without the noxious weed. Your old college friend asks you to determine herbicide costs to completely remove the noxious weed from the pasture with the noxious weed, and under the assumption that the desirable perennial grasses would increase production to the same value as in the adjacent pasture without the noxious weed. You estimate this cost at $100/ha.

51. **(5 pts)** Assuming that your old college friend only applies the herbicide to the 120 ha parcel with the high density of the noxious weed, and that 25% of the increase in desirable perennial grass production on this hectarage is available for consumption by the yearling steers, and monthly consumption for 1 AUM is 275 kg, how many dollars per ha are returned over the herbicide cost investment if the yearling steers gain 1 kg/steer/day and the selling price is 5$/kg?
    a. -$21/ha
    b. $5/ha
    c. $105/ha
    d. $122/ha

RANGE INVENTORY AND ANALYSIS PROBLEM – 10 points total

During the 2012 drought, the Grass is Taller than Stirrups on My Saddle ranch in Kansas reduced herd size by 60%, down to 160 cows year round (AUE = 1.3). By 2014, improving environmental conditions allowed the owners to increase cow numbers by 25% over the 2012 herd size. With an exceptional 2014 growing season, and projected better than average conditions for precipitation in 2015 by the Climate Prediction Center, the owners are looking to fully restock their ranch in 2015. The owners are looking at two options: 1) purchase bred cows (AUE = 1.3) on January 1, 2015 at a cost of $3,500 each. It is expected that the weaning calf percentage of these cows is 90%, and that steer calves (75% of the calf crop due to use of sexed semen when the cows were artificially inseminated) would sell for $2100 each, and heifer calves (25% of calf crop) would sell for $1750 each; 2) purchase bred replacement heifers (AUE = 1.0) on January 1, 2015 at a cost of $4250 each. It is expected that the weaning percentage of these bred heifers is 90%, and that steer calves (50% of the calf crop) would sell for $2100 each, and heifer calves (50% of calf crop) would sell for $1750 each. Assume that the total (fixed and variable) cost of running either a bred cow or a bred replacement heifer is $800 per animal, and that open cows/replacement heifer after weaning are sold for $1500 each.

52. **(10 pts)** Using option 1 (purchase bred cows), how much of the original purchase price remains to be repaid at the end of 2015, assuming no interest on the money used for purchasing the cows?
    a. $451,750
    b. $467,750
    c. $483,500
    d. $497,750
    e. $514,000