Horse Animal Unit Equivalent (AUE) Considerations and Wild Horse Ranch (WHR) Carrying Capacity Estimates

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(A) Animal Unit Equivalents

1. **Animal Units (AUs) are used for stocking rates relative to animal forage demand and rangeland forage supply.**
    a. The basis for an AU is the forage required by a 1,000 pound cow with a calf.
    b. All Animal Unit Equivalents (AUEs) for all other grazing animal species are relative to the 1,000 pound cow/calf AU basis.
    c. Example: If a sheep AUE is 0.2, then 5 sheep require the same forage as a 1,000 pound cow with a calf.
2. **AUEs scale with animal size, metabolic rate, and digestive physiology.**
    a. Horses are cecal digesters and employ a high intake strategy (i.e., less efficient digestion than a true ruminant).
    b. Consequently, a horse will consume 20-65% more plant material by volume compared to a domestic cow of equivalent size (Hanley 1982; Menard et al. 2002; references in footnotes of Table 1).
    c. AUE values for mature horses range from 1.00 to 2.00 (Table 1) with 6 of 10 sources using an AUE value ranging from 1.20 – 1.25 (Table 1). Thus, I suggest a mature horse AUE of 1.25 (Stam et al. 2018) (adjusted up for larger size horses (i.e., draft stock).
3. **The forage amount an AU requires for 1 month (AUM) is 750 pounds of forage (Stam et al. 2018**).
    a. For a mature horse (1.25 AUE) they would then require 937.5 pounds of forage per month (*calculation is 1.25 AUE x 750 pounds of forage*) or 11,250 pounds of forage for an entire year (*calculation is 937.5 pound of forage per month x 12 months*).

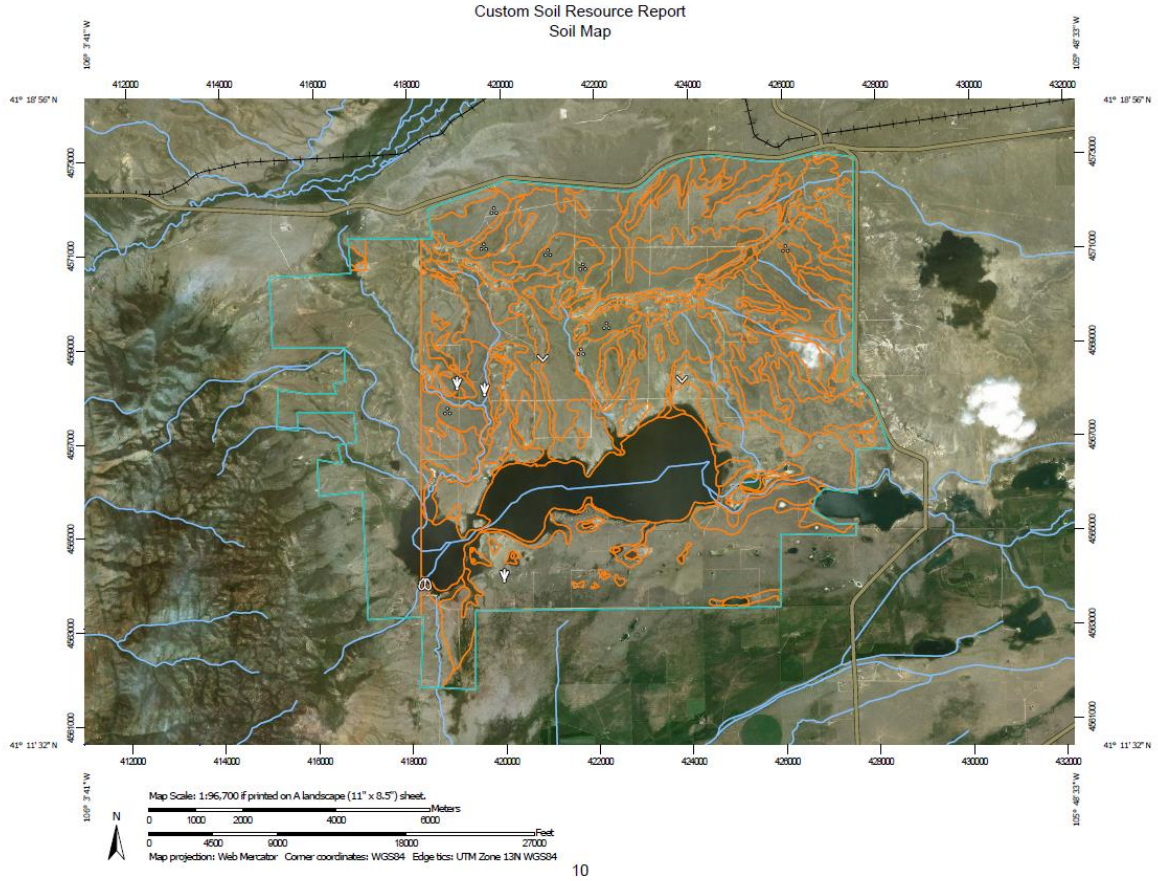
Table 1. State, Federal, and International AUE values for mature horses (Ordered from lowest to highest mature horse AUE value reported).

Source	Location	Mature Horse AUE
[1]Congressional Research Service (2019; citing BLM; footnote on page 2 equates an AUM as 1 cow or 1 horse occupancy on the range for month as 1 AUM)	USA	1.00
[2]MN Pollution Control Agency (Feedlot Animal Unit Capacity Calculator 2019)	Minnesota, USA	1.00
[3]National Range and Pasture Handbook (2006; Chapter 6, MT Table 6-5)	Montana, USA	1.10
Note AUEs for yearling horses (0.75) and 2 year old horses (1.0)		
[4]Manitoba, Canada Government (2019)	Manitoba, Canada	1.20
[5]FSH 2209.15 – Federal Range Management Annual Reports Handbook (1991)	USA	1.20
[6]Utah State University (Pratt and Rasmussen 2001)	Utah, USA	1.25
[7]Global Rangelands (based on Vallentine 1990)	Global	1.25
[8]USDA NRCS (Nelle and Reinke 2019)	Texas, USA	1.27
[9]University of Wyoming Extension (Stam et al. 2018)	Wyoming, USA	1.25 – 1.35
[10]USDA NRCS (Ogle and Brazee 2009)	Idaho, USA	1.25 – 2.00

[1]https://fas.org/sgp/crs/misc/RS21232.pdf
[2]https://www.pca.state.mn.us › sites › default › files › wq-f3-30
[3]https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_051957.pdf
[4]https://www.gov.mb.ca/agriculture/crops/production/forages/animal-unit-months-stocking-rate-and-carrying-capacity.html
[5]https://www.fs.fed.us/im/directives/fsh/2209.15/2209.15,10.txt
[6]https://extension.usu.edu/rangelands/ou-files/Determine_Stocking_rate.pdf
[7]https://globalrangelands.org/inventorymonitoring/unitequivalents
[8]https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_002433.pdf
[9]http://wyoextension.org/publications/html/B1320/
[10]https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn9390.pdf
[11]Hanley, T.A., 1982. The nutritional basis for food selection by ungulates. Journal of Range Management 35, 146–151
[12]Menard, C., Duncan, P., Fleurance, G., Georges, J., Lila, M., 2002. Comparative foraging and nutrition of horses and cattle in European wetlands. J. Appl. Ecol. 39, 120–133.

(B) Carrying Capacity Estimates

1. **Carrying capacity is a reflection of the available forage supply that can provide for the nutritional requirements of a number of grazing animals for a long-term period of time while sustaining the soil and plant resources.**
2. To determine the carrying capacity of the WHR, I used Soil Survey Geographic Database (SSURGO)-based Web Soil Survey (WSS) estimates provided by the United States Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS) of rangeland forage production (see map below) for an area of interest encompassing the entire WHR (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).



3. After removing map unit 245 (water) there were 39 major soil map units (including NOTCOM which had no digital data available) from which I took the mean forage production value averaged across any minor soil map units within each major soil map unit.
4. In one case, rocky outcrops were a minor soil map unit within a major soils map unit (specifically 114—Blackhall-Satanka-Rock outcrop complex, 5 to 20 percent slopes) and I assigned a value of 0 lbs/acre and used that as part of the calculation of mean forage production values for the major soils map unit with which it was associated (e.g., factoring in unproductive areas on the WHR).

5. In one case, there was no forage production values for a major soil map unit (specifically 162—Folavar-Borollic Camborthids complex, 0 to 3 percent slopes; representing 98.8 acres or 0.4% of area of interest). In this case, I assumed forage production values based on a weighted average of the rest of the WHR.
6. I also did a quality control step where I looked for particularly unproductive portions of the WHR that I have seen in person to determine if values were lower than other areas (such as 120—Bosler-Borollic Camborthids complex, 0 to 8 percent slopes, that runs along the ridge to the north of Big Hollow and out onto the flats on top). Forage production estimates met my relative expectations.
7. Approximately 16.7% of the area of 22,624.8 acre (non-water) area interest was land with no digital data available. This represented the western fringe of the WHR or 3,775.9 acres. In this case, I assumed forage production values based on a weighted average of the rest of the WHR. In addition, the digitizing of the western boundary of the WHR may be slightly inaccurate but given the lack of digital data it is likely irrelevant.
8. To determine carrying capacity, I then calculated total forage available for each major soil map unit for favorable, average, and below average years (considered as wet, average, and dry) by multiplying estimated pounds of forage per acre by acres represented by each major soil map unit. I then summed the total forage production for the wet, average, and dry years across all major soil map units to derive the ***total forage biomass production***.
9. For horse utilization assumptions, I applied a 'take half, leave half' assumption for which 25% of the forage is assumed to be ingested by horses, 25% is assumed to be trampled and wasted, and the remaining 50% is assumed to be available for wildlife and for residual soil cover and plant regeneration. Thus, I then multiplied the total forage biomass production by 0.25 to derive the ***total forage biomass available for horse consumption***.
10. For AUE and horse demand assumptions, I then applied a mature horse AUE value of 1.25 which based on Stam et al. (2018) suggests that a horse would require 11,250 pounds of forage annually.
11. To determine the number of mature horses the WHR could accommodate, I then divided the total forage biomass available by 11,250 pounds of forage required per horse annually.
12. **Thus, assuming the USDA-NRCS forage production estimates are reliable, the AUE mature horse estimate is reflective of horse forage requirements, and the conservative utilization estimates reflect reality, the WHR has a carrying capacity of 319-656 horses depending on dry or wet conditions. Across years and assuming average conditions, this equates to 505 horses (Table 2).** See Appendix A for acres, % of area, forage production relative to year type, and associated calculations below.

Table 2. Forage biomass production and availability for horse consumption based on a 25% Harvest Use Efficiency standard for the Wild Horse Ranch.

Metric	Wet Year	Average Year	Dry Year
Total forage biomass production	29,492,216 lbs	22,750,455 lbs	14,322,493 lbs
Total forage biomass available for horse consumption (25% of production above)[1,2]	7,373,054 lbs	5,687,613 lbs	3,580,623 lbs
Number of mature horses annually (1.25 AUE or 11,250 lbs forage per year required)	**655 horses**	**505 horses**	**318 horses**

[1]*Based on Harvest Use Efficiency of 25% or that 25% of the forage is assumed to be ingested by horses, 25% is assumed to be trampled and wasted, and the remaining 50% is assumed to be available for wildlife and for residual soil cover and plant regeneration.*

[2]*Carter R., Thacker E., Heaton K., and Burritt B. (2019). Grazing and harvest efficiency of forage by cattle on western rangelands. Utah State University Available online at: https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3039&context=extension_curall*

Appendix A. Major soil map units, acres, proportion of area, and dry weight forage production estimates for wet, average, and dry years at the Wild Horse Ranch. Data derived from Soil Survey Geographic Database (SSURGO)-based Web Soil Survey (WSS) on October 2nd, 2019.

			Total dry-weight production (lbs/ac)			*Total biomass available (lbs)*		
Map unit symbol and soil name	***Acres***	***% of AOI***	***Wet year***	***Avg year***	***Dry year***	***Wet year***	***Avg year***	***Dry year***
102—Alcova-Borollic Camborthids complex, 0 to 8 percent slopes	341	1.4	1450	1150	650	494450	392150	221650
103—Alcova, shallow substratum-Lupinto-Dahlquist complex, 0 to 8 percent slopes	1284.8	5.2	1,200	900	700	1541760	1156320	899360
113—Blackhall-Browtine, moist, complex, 15 to 45 percent slopes	43.3	0.2	1,450	1100	750	62785	47630	32475
114—Blackhall-Satanka-Rock outcrop complex, 5 to 20 percent slopes	61.7	0.2	900	700	466	55530	43190	28752.2
116—Blazon-Delphill complex, 20 to 45 percent slopes	199.9	0.8	1,200	950	550	239880	189905	109945
120—Bosler-Borollic Camborthids complex, 0 to 8 percent slopes	120.8	0.5	1,450	1150	650	175160	138920	78520
126—Browtine very gravelly fine sandy loam, 0 to 8 percent slopes	714.3	2.9	650	450	300	464295	321435	214290
127—Browtine-Hilltoppe very gravelly sandy loams, 0 to 8 percent slopes	72.9	0.3	625	450	275	45562.5	32805	20047.5
132—Canburn loam, 1 to 4 percent slopes	21.1	0.1	4,300	3,700	3,000	90730	78070	63300
135—Carmody-Edlin fine sandy loams, 15 to 45 percent slopes	43.2	0.2	1,200	900	700	51840	38880	30240
136—Carmody-Ryan Park fine sandy loams, 6 to 15 percent slopes	57.5	0.2	1,500	1,200	700	86250	69000	40250
139—Chaperton, moderately saline-Blazon complex, 8 to 20 percent slopes	94.9	0.4	950	750	500	90155	71175	47450
140—Chaperton-Poposhia complex, 3 to 30 percent slopes	3395.4	13.7	1,200	900	700	4074480	3055860	2376780
146—Cushool-Diamondville fine sandy loams, 0 to 3 percent slopes	9	0	1,400	1,100	600	12600	9900	5400
148—Dahlquist-Rawlins-Browtine complex, moist, 3 to 15 percent slopes	466.6	1.9	1,700	1,300	800	793220	606580	373280
149—Dalecreek-Kovich complex, 0 to 9 percent slopes	40.3	0.2	5,500	4,750	3650	221650	191425	147095
150—Delphill-Blazon complex, 3 to 20 percent slopes	14.8	0.1	1,200	950	550	17760	14060	8140
151—Diamondville-Cushool complex, 3 to 15 percent slopes	115.4	0.5	1,450	1,150	650	167330	132710	75010
153—Elkol clay loam, 0 to 8 percent slopes	22.5	0.1	650	500	300	14625	11250	6750
154—Elkol-Gerdrum family complex, 1 to 8 percent slopes	678.4	2.7	1575	1150	750	1068480	780160	508800
155—Elkol-Gerdrum family, overflow complex, 0 to 3 percent slopes	400.8	1.6	2,500	1,800	1,200	1002000	721440	480960
*162—Folavar-Borollic Camborthids complex, 0 to 3 percent slopes	98.8	0.4	***1035***	***798***	***503***	133568	103043	64858
163—Forelle loam, 0 to 6 percent slopes	21.6	0.1	1,400	1,100	600	30240	23760	12960
165—Forelle-Diamondville association, 3 to 15 percent slopes	49.4	0.2	1,400	1,100	600	69160	54340	29640
178—Kiltabar-Tismid complex, 0 to 3 percent slopes	143.6	0.6	2,500	1,800	1,200	359000	258480	172320
184—Luhon loam, 1 to 5 percent slopes	261.1	1.1	1,200	900	700	313320	234990	182770
185—Luvar-Stylite-Diamonkit complex, 1 to 8 percent slopes	278	1.1	1,333	1033	633	370574	287174	175974
190—Moyerson-Kemmerer complex, 3 to 20 percent slopes	84.7	0.3	700	500	350	59290	42350	29645
192—Pahlow gravelly sandy loam, 0 to 3 percent slopes	3039.1	12.2	1,500	1,200	700	4558650	3646920	2127370
194—Pinelli clay loam, 0 to 6 percent slopes	8.5	0	1,300	1,000	500	11050	8500	4250
198—Poposhia-Forelle complex, 1 to 8 percent slopes	3999.2	16.1	1,400	1,100	600	5598880	4399120	2399520
199—Poposhia-Chaperton association, 6 to 12 percent slopes	762.3	3.1	1,400	1,100	600	1067220	838530	457380
200—Rainbolt-Morset association, 3 to 25 percent slopes	252.5	1	2,000	1,500	800	505000	378750	202000
216—Rock River sandy loam, 2 to 6 percent slopes	480.4	1.9	1,400	1,100	600	672560	528440	288240
228—Stunner sandy loam, 2 to 8 percent slopes	272	1.1	1,400	1,100	600	380800	299200	163200
229—Stunner-Borollic Camborthids complex, 2 to 5 percent slopes	51.5	0.2	1450	1150	650	74675	59225	33475
236—Tisworth-Gerdrum family loams, 1 to 8 percent slopes	487.6	2	650	500	300	316940	243800	146280
237—Tisworth-Gerdrum family complex, 0 to 6 percent slopes	360	1.4	900	700	500	324000	252000	180000
245—Water	2224.7	9				0	0	0
*NOTCOM—No Digital Data Available	3775.9	15.2	***1035***	***798***	***503***	3,908,057	3,013,168	1,899,278
TOTAL NOT INCLUDING WATER AND NOTCOM	18848.9	76				25,584,160	19,737,286	12,423,215
TOTAL (LAND AND WATER IN AOI)	24849.5	100.2						
TOTAL GRAZEABLE ACRES FORAGE PRODUCTION (MINUS WATER)	**22624.8**	**91.2**				**29,492,216**	**22,750,455**	**14,322,493**
Multiply by 0.25 for horse grazing (25% ingested, 25% trampled/waste, 50% residual/wildlife)						7,373,054	5,687,613	3,580,623
TOTAL NUMBER OF MATURE HORSES @ 1.25 AUE Or (Divided by 11,250 lbs per horse year)						**655**	**505**	**318**

**NOTCOM and 162 VALUES BASED ON WHR WEIGHTED AVERAGE (Wet = 1035 lbs/ac, Avg = 798 lbs/ac, Dry = 503 lbs/ac)*