Application of High Fungal Compost
Oswald GrassFed WSARE Report
FREMONT COUNTY, COLORADO

December 19, 2022

Prepared By:
Annie Overlin and Steve Oswald

Submitted to:
Western Sustainable Agriculture Research and Education

Project Description

This report describes the baseline vegetation communities pre and post treatment 2020-2022.

This report summarizes visual and quatitative assessments from May 2020 through October 2022 and EarthFort microbial test, Ward labs Soil test and plant tissue tests taken in 2021.

1.1 Setting

The Oswald Ranch and associated BLM, USFS, and State Land Leases cover 12,000 acres. All private lands are under conservation easement with Colorado Cattleman's Land Protection Trust. The ranch is located south of Cotopaxi, Colorado and is climactically classified as semi-arid. Precipitation ranges from 11-18 inches with the majority of moisture as snow between December to May and afternoon thunderstorms mid-July through early August. Rainfall typically occurs as high intensity thunderstorms during the growing season. The average annual temperature in Coaldale is 44.6 degrees Fahrenheit. Typically, the fall is dry. Summer days tend to be warm and dry with the temperature dropping significantly at night.

SOIL TYPE and NATIVE VEGETATION The Curecanti soil series dominates much of the area and is typified by fine sandy to gravelly sandy loam. The project area is located within the Southern Rocky Mountain Foothills Major Land Resource Area (MLRA 48). Consistent with this MRLA, the surrounding areas are characterized by hogbacks, ridges, and hills that are dominated by a mixture of pinyon pine (*Pinus edulis*), mountain mahogany (*Cercocarpus montanum*), blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Hesperostipa comata*), and wheatgrasses (*Elymus* spp).

BACKGROUND The ranch operates as a cow/calf beef operation and marketed as grass-finish for direct marketing. They run 200 mother cows on the ranch year-round with 50 yearlings that graze in the early spring and early summer (4 months). Irrigated ground is also sub-irrigated and dominated by wet meadow species. There is a desire to return irrigation water to the areas previously used for cropping for use as a finishing pasture with a mix of perennial and cover crop species.

This report focuses on irrigated and non-irrigated lands. These pastures are crucial to the operation as finishing pastures and for the cow/calf operation throughout the summer and fall. Irrigated pastures are irrigated throughout the summer months and grazed using high stock density from approximately June 1st through November 30. Non-irrigated pastures are grazed less intensively and timed with phenology. All pastures are rested adequately to allow regrowth of key grass species.

1.2 Methods

The project area was surveyed the last week in September 2020-2022. Percent cover was sampled using Daubenmire frames (Table 1). Nomenclature follows PLANTS Database (USDA, NRCS 2022). In the cheatgrass pasture percent cover was sampled 2020-2022. Percent cover was only sampled in 2020 and 2022 in the Wet Meadow and Smooth brome pastures. Water infiltration was sampled in 2020-2022 in the cheatgrass pasture. Production data was taken in control plots and in the fall of 2022. Soil samples and plant tissue tests were taken at peak production.

Baseline Vegetation Characterization

Treatments were performed 2020-2022 in the following pastures. Tables 1-4 represents the percent cover and production of these pastures and represents changes over time.

Nonnative Pasture (Cheatgrass Pasture)

The nonnative pasture community dominates the Cheatgrass pasture. This community occurs in areas that were previously cultivated.

Dry Meadow (House or Pond field)

This community is distinguished from the nonnative pasture by a dominance (monoculture) of smooth bromegrass.

Wetland meadow (Kaess place)

Wetland species including Nebraska sedge, horsetail, and Arctic Rush and legumes dominate this pasture. All of these species have very deep root systems and are capable of surviving in drought conditions and inconsistent ground water tables.

Table 1. Vegetation Cover of Smooth brome pasture, Cheatgrass Pasture, and Wet Meadow (Kaess) Pastures

	Smooth Brome 2020	**Smooth Brome 2022**	**Cheatgrass 2020**	**Cheatgrass 2021**	**Cheatgrass 2022**	Wet meadow 2020	Wet meadow 2022
Bareground	8	9	12	12	15	1	1
Litter	8	8	2	2	1	5	6
Smooth Bromegrass (*Bromus inermus*)	82	78	2	2	3	34	26

Cheatgrass (*Bromus tectorum*)			15	2	4		
Green Needle Grass (*Stipa viridula*)			2	2	3		
Yarrow (*Achillea millefolium*)		1	0	0	0	3	4
Kochia (*Bassia scoparia*)			7	6	16		
Russian thistle (*Salsola tragus*)			8	6	31		
Curly cup gumweed (*Grindelia squarrosa*)			2	1	2		
Western wheatgrass (*Pascopyrum smithii*)			6	7	8	4	5
Horsetail (*Equisetum laevagatum*)			0	0	0	2	3
Arctic rush (*Juncus arcticus*)			0	0	0	8	9
Nebraska sedge *(Carex nebrascensis*)			0	0	0	12	15
Canada thistle (Cirsium arvense)	0	1	0	0	0	1	1
Bindweed (*Convolvulus arvensis*)	0	1	1	4	3	10	8
Alfalfa (*Medicago sativa*)	1					9	10
Clover (Trifolium sp)	1	2				11	12
Purslane (*Portulaca oleracea)*			14	4	2		
Storksbill (Erodium cicutarium)			12	4	3		
Cover crop mix (sorghum, triticale, turnip, cowpea, millet)			17	48	9		

Smooth Brome (pond/house) pasture

Cheatgrass Pasture

Wet Meadow (Kaess Place)

Table 2. Production of treatments in wet meadow and smooth brome meadow

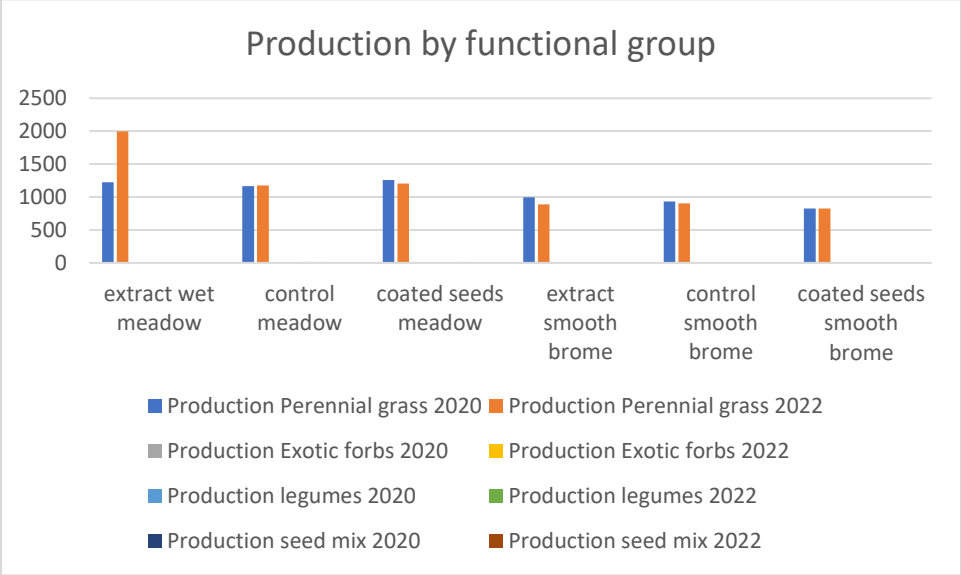

Table 3. Production of treatments in Cheatgrass pasture

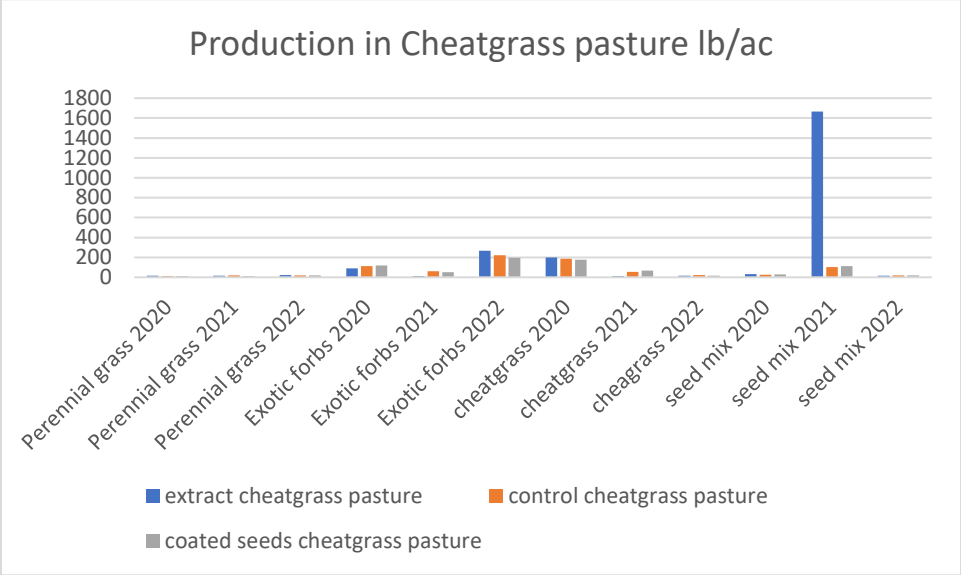

Table 4. Water Infiltration

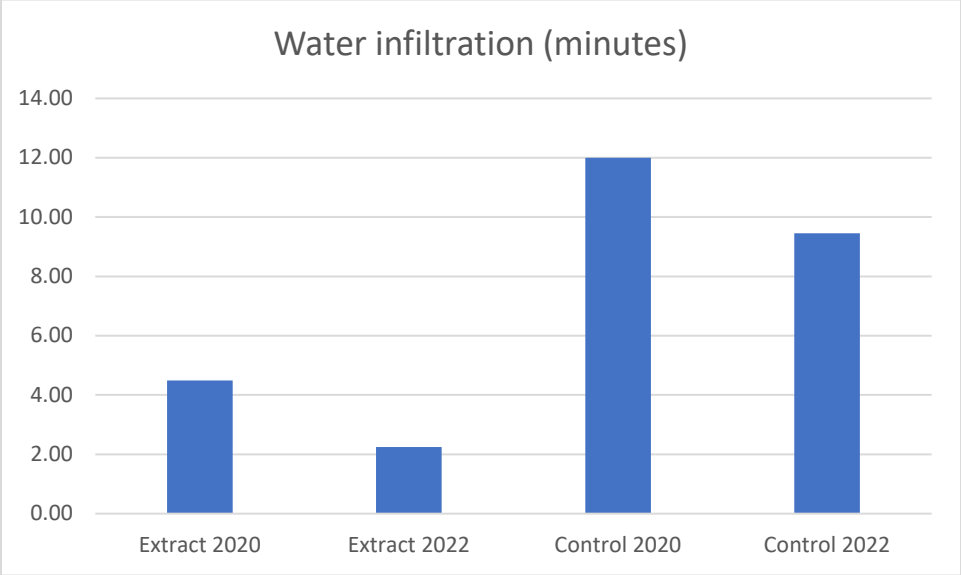

Table 5. Soil Biology (Earthfort tests)

2021 Earthfort Data	Mine pasture (blue grama)	Smooth brome pasture	Notes	Purslane Cheatgrass pasture	Cover crop in cheat grass
Test	Earthfort	Earthfort		PLFA	PLFA
Total Fungi ug/g	2560- good biomass	295 (low fungal biomiass (foods and fungi)	Low numbers add vermicast	61	70
Total Bacteria ug/g	476- good	306-good	HIGH BACTERIA	1286	1428
Active Fungi ug/g	4.40	1.98	Critically low activity add fungal foods like fish and humate's	0	8.81
Active Bacteria ug/g	16.03	1.74	low Bacteria activity add bacterial foods such as seaweed and molasses	0	34.91

TF: TB Ratio	5.38 (good range 1-10)	.96 (too bacterial)	Bacteria dominate	.049	.047
AF: AB Ratio	0.27	1.14- becoming fungal		0	0
Flagellates number/g	0	4676	Lack species diversity indicated by low amoebae Nutrient cycling is limited because of this. High numbers indicate waterlogging/ compaction	0	0
Amoebae number/g	0	0		0	0
Ciliates number/g	0.00	0.00		0.00	0.00
VAM Colonies %	0	Not ordered		0.11	0.04
N Cycling lbs/ac	<5	<25	N Levels dependent on plant needs estimated availability over 3-month period	0	0

Results

Major results include the following:

- No significant results were observed or recorded between the treatments within the smooth brome (pond/house) or wet meadow (Kaess) pastures.
- There were significant increases in both production and percent cover of the cover crop in the Cheatgrass pasture in 2021 in the plots sprayed with extract.
- There were no significant vegetation differences in the Cheatgrass pasture in 2022 in any of the treatment plots.
- There was a significant decrease in water infiltration in plots treated with Extract in both 2020 and 2022.
- There was a significant increase in active fungi and bacteria in the cheatgrass plots treated with Extract.

WARD Laboratories, Inc.

Ag Testing - Consulting

Account No. : 23789

OSWALD, STEVE
PO BOX 304
COTOPAXI, CO 81223-0304

Soil Analysis Report

Invoice No. : 1347040
Date Received : 06/21/2021
Date Reported : 06/23/2021

Results For : STEVE OSWALD
Location :

Sample ID / Lab No.	Soil pH 1:1	Modified WDRF BpH	Soluble Salts 1:1 mmho/cm	Excess Lime Rating	Organic Matter LOI-%	KCl Nitrate ppm N	Depth / Nitrate Lbs N/A	Method / Phosphorus ppm P	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	Na ppm	M-3 Sulfate ppm S	DTPA Zn ppm	Fe ppm	Mn ppm	Cu ppm	Hot Water Boron ppm B	CaNO3 Chloride ppm Cl	Sum of Cations me/100g	% Base Saturation H	K	Ca	Mg	Na
KAESS MEADOW							0 - 8 in	O-P																	
72611	7.3		0.13	NONE	2.7	1.4	3	22.4	321	1731	237	25	1.1	0.77	38.4	12.4	1.10	0.58		11.6	0	7	75	17	1
POND FIELD							0 - 8 in	O-P																	
72612	7.2		0.14	NONE	3.0	0.9	2	17.7	213	1692	202	17	7.2	1.11	18.7	12.5	0.66	0.57		10.8	0	5	78	16	1
CHEATGRASS FIELD							0 - 8 in	O-P																	
72613	6.9		0.18	NONE	1.9	9.3	22	33.8	439	1153	165	22	1.9	1.38	33.0	11.6	0.54	0.49		8.4	0	13	69	16	1
HOUSE FIELD							0 - 8 in	O-P																	
72614	7.3		0.18	NONE	4.0	0.7	2	37.6	428	1711	243	27	8.0	1.76	20.3	7.8	0.67	1.12		11.8	0	9	73	17	1
CRESTED WHEAT FIELD							0 - 8 in	O-P																	
72615	6.7		0.08	NONE	2.1	0.9	2	18.1	228	1235	129	25	5.2	1.15	24.2	13.8	0.70	0.29		7.9	0	7	78	14	1

Reviewed By: Nick Ward

Copy : 1 **6/25/2021**

Bus: 308-234-2418 Fax: 308-234-1940 Web site www.wardlab.com 4007 Cherry Ave., P.O. Box 788 Kearney, Nebraska 68848-0788

Plant Tissue Test 2020

PLANT TISSUE TEST OSWALD- Data taken 7/24/2020

Sample ID	% N	% P	% K	% S	% Ca	% Mg	ppm Zn	ppm Fe	ppm Mn	ppm Cu	ppm B	% Cl	% Na	ppm Al	ppm Mo
Green needle in CHEATGRASS	2.129	0.148	1.77	0.15	0.373	0.122	35	658	67	10.3	4.8	0.45	0.01		0.65
BINDWEED IN CHEAT GRASS	3.933	0.323	3.43	0.29	1.098	0.280	28	1011	142	10.0	20.4	0.48	0.01		0.69
KNAPWEED DRY MEADOW	1.270	0.256	1.74	0.21	1.446	0.158	45	252	63	10.3	36.2	0.74	0.02		0.79
SMOOTH BROME DRY MEADOW	2.880	0.248	1.35	0.19	0.531	0.171	16	329	106	7.8	10.3	0.41	0.01		2.31
THISTLE IN TRITICALE RUSSIAN	4.483	0.297	5.52	0.28	3.112	1.110	22	138	48	7.4	24.4	1.03	0.03		0.37
SWEET CLOVER KAESS PLACE	2.774	0.242	1.85	0.37	1.605	0.304	18	218	54	7.3	27.8	0.24	0.02		4.25
SMOOTH BROME KAESS PLACE	3.121	0.338	2.45	0.28	0.947	0.209	27	909	221	10.7	12.6	0.46	0.02		3.3

Russian thistle, mustard, curly top gumweed, cheatgrass (perfect conditions), different weed each season

Nutrient Effects	
Low Nitrogen	Nitrogen is low in the House/Pondfield pasture. N can reduce the uptake of trace elements and reduce growth of the plant. In animals N is essential for building amino acids and proteins.
Low Magnesium	Magnesium plant sample results are low in all pastures, not uncommon for ***soils*** with high magnesium and low levels of Nitrogen (due to reduced gas exchange and microbial function). Magnesium is critical to chlorophyll production and photosynthesis function. In addition, low Na+ will contribute to reduced Magnesium absorption. Milk production and calf growth may become comprised.
Phosphorus	Low phosphorus effects plant growth and Brix tests are a great way to measure its function. It is the key component to sugar production for plants to feed root

	zones and microbial communities. Perennial grasses in the Cheatgrass pasture were deficient in P which effects bone density, growth, and fertility. Weedy species were sufficient.
Low Potassium	Potassium levels were variable throughout different species within pastures. For example, in the cheatgrass pasture, similar to P, K is deficient in perennial grass but sufficient in bindweed. Equally important, in pastures such as the House/Pond field where it is a monoculture, K is low. This is important in the House/Pond because K controls over 50 enzymatic processes in a plant and a key component to production and the ability to control stomata function during periods of heat stress. If animals only eat bromegrass, they are at risk of milk fever.
Low Calcium	All species in the cheatgrass pasture and house field are low in calcium. A deficiency in Calcium can reduce water retention, OM, and affect pH negatively. It can also affect the uptake of Magnesium. The Ca:P ratios are also important as if either minerals is excess, they can form an insoluble molecule and cause soft tissue mineralization. A Ca:P>1.2 and may result in either bone demineralization/lameness, milk fever and low growth. This is the case in both the Cheatgrass pasture, Woodlot (if they only ate Russian thistle) and the House pasture (smooth brome).
Low Copper	The House/pond pasture shows low levels of Copper. A deficiency in this has implications for animal health. Scours, hair /wool stiff, reddish tinge on a black cow. Poor clover nodulation, clover growth & animal growth. Increased vulnerability to worms and ticks. Low copper in wheat can relate to increased risk to fungal disease.
Low Boron	All pastures are low in Boron. Boron regulates sap flow and is critical for plant structure and function. Animals don't grow well, have brittle bones and hunched backs. Clovers don't thrive. Inflammatory. Poor immune function, increased risk of mortality, osteoporosis, and cognitive deterioration. poor bone density, embryonic development, wound healing. Low estrogen in older animals.
Low Zinc	All pastures are very low in zinc possibly a result of antagonisms with Ca and Phosphorus. A deficiency in zinc reduces plant sugar usage. Leads to low Vit A, runny eyes, poor night vision. Thick, dry scaly skin. Scabs on teats. Thin patchy hair, none around eyes, scald, weak muscles, slow calving, high SCC (somatic cell counts). Poor sperm motility.
High Fe	Excessive Iron will place high oxidative stress on the animal. Copper depletion are apparent with high iron intakes. Low Zinc can increase Iron absorption. Also other deficiencies in other cations (Ca+, Mg, andK+ can increase uptake).

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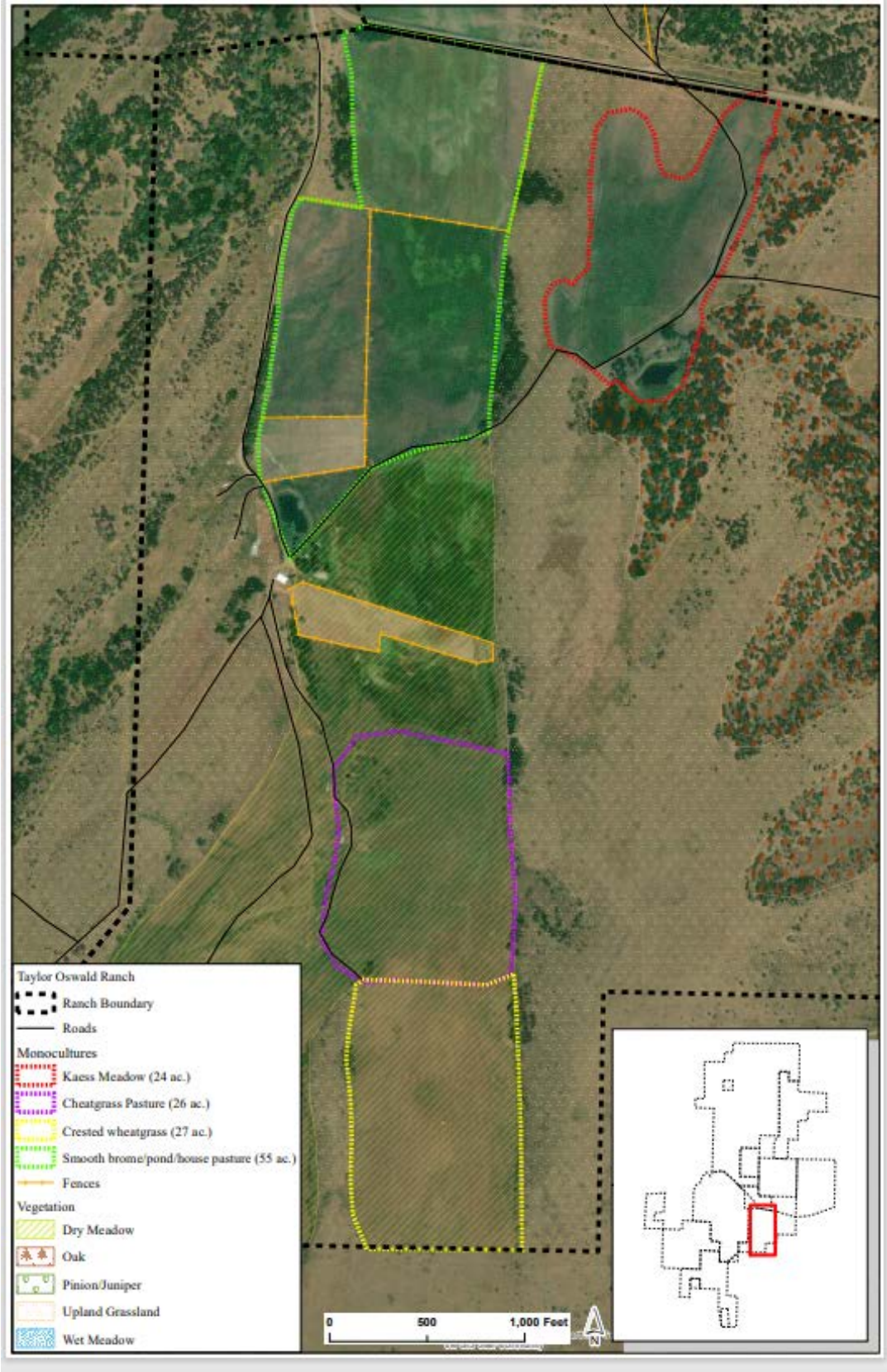
Taylor Oswald Ranch
Ranch Boundary
Roads
Monocultures
Kaess Meadow (24 ac.)
Cheatgrass Pasture (26 ac.)
Crested wheatgrass (27 ac.)
Smooth brome/pond/house pasture (55 ac.)
Fences
Vegetation
Dry Meadow
Oak
Pinion/Juniper
Upland Grassland
Wet Meadow
0
500
1,000 Feet
N

2021 Results High Fungal Compost Extract (warm and cool season covers)

References

Duniway, M.C., B.T. Bestelmeyer, A. Tugel. 2010. Soil processes and properties that distinguish ecological sites and states. Rangelands 32:9-15.

Lyle F. Friesen, Hugh J. Beckie , Suzanne I. Warwick, and Rene C. Van Acker. 2008. The biology of Canadian weeds. *Kochia scoparia*. The Canadian Journal of Plant Science.

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. The National Wetland Plant List: 2016 wetland ratings. Phytoneuron 2016-30:1-17. Published April 28, 2016. ISSN 2153 733XU.S.

Karachi, Moses and Rex D. Pieper. 1987. Allelopathic Effects of Kochia on Blue Grama. Journal of Range Management . 40(4), July 1987

Overlin, Annie and Tamzen Stringham. 2017. Conversion of Agriculturally Cultivated Wetland. Journal of Range Management. November 2017

Stringham, T.K., J.P. Repp. 2010. Ecological site descriptions: Consideration for riparian systems. Rangelands 32:43-48.

U.S. Department of Agriculture. U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS). 20. Web Soil Survey. Available at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. Last accessed: August 01, 2022

U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS). 2022. The PLANTS Database. Available at: http://plants.usda.gov. National Plant Data Team, Greensboro, NC 27401-4901 USA.