LTAR Common Experiment Coordination Survey

This survey will be used to systematize information about common experiments across LTAR sites in order to facilitate communication among scientists and other stakeholders and coordinate measurements and inferences across the network. Responses will be synthesized and presented as a baseline for discussion at a follow-up workshop at Archbold Biological Station in February 2016.

We would appreciate your response by January 30, 2016. Thank you!

Please note:

- Mozilla Firefox browser works best with this questionnaire
- Completion of all fields except "References" is required (*) for form submission. To skip a field, write "NA"
- Drafts cannot be saved, but text will be retained if you keep your browser open
- Please direct any questions to Sheri Spiegal at spiegal@nmsu.edu

1. Study site context

a) Location description * Jornada Experimental Range

Y Coordinate *	X Coordinate *	Datum *	UTM Zone *
3610606.5	336026	WGS_1984	13N

b) Site ownership * USDA ARS

c) Major Land Resource Area/Ecoregion *

MLRA 42, Southern Desertic Basins, Plains, and Mountains

d) Dominant landforms and soil taxa in MLRA/Ecoregion *

Desert basins, plains, and mountains; Aridisols and Entisols, with some Mollisols and Vertisols depending on landform and elevation.

e) Dominant land uses in MLRA/Ecoregion *

Livestock grazing; housing subdivisions; some dryland farming and military use. About 1/3 of MLRA 42 is federally owned.

2. What are the "business as usual" (BAU) and aspirational (ASP) treatments? *(150 word limit)*

Business as usual *

Extensively managed, light to moderately stocked year round cow/calf operation with "old world" cattle genetics, i.e., classic Bos taurus breeds, esp. Angus and Hereford, which are a result of artificial selection since introduced to the US.

Grass-fed on desert range; grain-finished in Midwestern feedlots; packed and shipped from Midwest.

Aspirational *

Extensively managed, light to moderately stocked year round cow/calf operation with "new world" cattle genetics, i.e., original cattle genetics introduced to the Americas between and 1493 and ~1516 and undergoing ~80-200 generations of "natural selection" in less managed arid environments in Mexico. (Bos taurus Criollo biotype).

Grass-fed on desert range; currently grass-finished on desert range at 30 months, eventually grain-finished at regional feedlots modified for small body size and nonuniform conformation; packed and shipped from region.

3. With reference to specific processes and mechanisms, what are the main limitations/problems associated with BAU?

a) With regard to production? *(300 word limit)* *

Livestock producers in the southwestern U.S. are faced with multiple, persistent challenges, including low and variable rainfall, spatial and temporal variability of primary production, and past ecological state changes that now limit forage availability. In non-drought years, with proper stocking rates and extensive land area, grazing can be year round with few inputs. Conversely, multi-year droughts can mean the grazing capacity can be nearly zero. Moreover, areas dominated by forage grasses have declined, and rangelands dominated by woody plants with low palatability are more common (Estell et al. 2012). Grazing capacities are expected to continue to decline with expected drying/warming trends.

Within the context of this spatial and temporal variability, BAU breeds tend to locally overgraze specific areas – patches dominated by dropseed, black grama, and threeawn, and areas adjacent to natural and artificial watering points – leaving abundant forage in other areas (Bailey 2004). Uneven forage utilization of BAU breeds translates into an overall reduction in meat production and economic return (Holechek 1992). Further, conventional systems that produce calves for sale into stocker systems within 6 months are highly sensitive to prolonged drought when grass forages are reduced or absent. Reductions in grass forages require expensive replacement forages and/or herd reductions. High cattle prices can limit post-drought restocking options.

Only about 50-75% of the permitted Animal Unit Months (AUMs) in the Las Cruces Grazing District allotments were used at any given time during the past 10 years (BLM). A combination of several factors may drive this underutilization. Allotments may support fewer animals than when AUMs were originally allocated, or ranchers may be exiting the business for reasons unrelated to economics. It is likely, though, that these fluctuations and underutilized allotments are also due to a clientele that is responsive to a system with high variability.

Looking ahead, the disadvantages associated with "old world" genetics in this arid environment are likely to be exacerbated with climate change across the region.

b) With regard to environmental effects? *(300 word limit)* *

Rainfall variability and stocking rate are principal controls over primary production in arid and semi-arid range landscapes (Briske et al. 2011); however, the uneven utilization characteristic of BAU breeds can impart deleterious environment effects.

Localized overgrazing can increase the number and size of patches of bare and compacted soils and accordingly can cause an increase in water and wind erosion. Areas adjacent to watering points are particularly susceptible (Briske et al. 2011).

Localized overgrazing on grass patches – exceeding safe targeted levels of utilization rates for grass forages of 35% or less – typically occurs on the sandy and gravelly soils with which grasses are associated. On these soils, interactions of heavy grazing, multiyear drought, and high winds lead to rapid, persistent, and sometimes irreversible grass loss (Bestelmeyer et al. 2013). Woody plants colonize patches with severely reduced grass cover (Peters et al. 2012) due to seed dispersal, reduced fire frequencies, and reduced competition from herbaceous plants (Bestelmeyer et al. 2009). Shrub-dominated states comprise coppice dunes and bare soils, and represent an overall increase in dust emissions (Gillette and Pitchford 2004) and a reduction in productivity (Bestelmeyer et al. 2011) and biodiversity (Bestelmeyer et al. 2009).

Livestock forage utilization and landscape use – in both BAU and ASP systems – can influence wildlife forage availability, contribute to wildlife-livestock competition, and influence wildlife movements. Wildlife responses to livestock are variable, with abundances declining, increasing, or not changing depending on species requirements and environmental conditions (reviewed in Briske et al. 2011).

c) Which ecosystem services are affected, at risk, and/or compromised by BAU and the processes described above?

Provisioning *

Beef production

Regulating *

Biological regulation, Air quality regulation, Erosion protection

Supporting *

Primary production, Biodiversity protection

Cultural & Amenity *

Cultural heritage

4. How is it believed that the ASP treatment will overcome/solve the production and environmental limitations/problems described in 3 a) and 3 b) (i.e., rationale)?

Base your response on the Ecosystem Service(s) indicated above *(100 word limit)*

Provisioning *

Example: Food: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Fiber: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Genetic Resources: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

Beef production: Preliminary data and anecdotal evidence suggest that Criollo possess traits and behaviors that may translate into favorable economics for livestock producers in the American Southwest: diet breadth, uniform forage utilization, reproductive capacity, and drought-condition weight maintenance (Anderson et al. 2015). With regard to diet breadth, anecdotal evidence suggests that Criollo may consume more shrubs than BAU breeds.

Preliminary enterprise budgets indicate that in comparison to BAU, ASP could bring a similar to improved level of net economic return (Diaz et al. 2015).

Regulating *

Example: Climate Regulation: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Waste Treatments: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Pollination: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

Biological regulation: The influence of Criollo on spatial and temporal patterns of above-ground net primary production (ANPP) may alter number, frequency, and spatial pattern of patchy grass to shrub state transitions. A reduction in these transitions could sustain or enhance multiple ecosystem services, including air quality regulation, primary production, and biodiversity protection.

Air quality regulation: The influence of Criollo on spatial and temporal patterns of ANPP may influence the configuration and number of patches of bare, erodible soils. A reduction or reconfiguration of these bare patches could result in reduced wind erosion (Webb and Strong 2011).

Erosion protection: Preliminary data suggest that compared with activity of BAU breeds, Criollo forage further from permanent sources of water (Peinetti et al. 2011). A reduction in activity in areas adjacent to watering points could result in reduced erosion in these areas (Bailey 2004).

Supporting *

Example: Primary Production: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Water Cycling: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Nutrient Cycling: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

Primary production: Criollo traits and behaviors may translate into economically viable beef production, despite spatial and temporal variability of primary production and past grass to shrub state changes.

The influence of Criollo on spatial and temporal dynamics of ANPP may differ from the influence of BAU.

Biodiversity protection: Livestock forage utilization and landscape use – in both BAU and ASP systems – can influence wildlife forage availability, contribute to wildlife-livestock competition, and affect wildlife movements. Wildlife responses to livestock are variable, with abundances declining, increasing, or not changing depending on species requirements and environmental conditions.

Cultural and Amenity *

Example: Educational Values: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Recreation: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.* Cultural Heritage: *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

Cultural heritage: If data reveal that Criollo can support or enhance economically sustainable beef production while causing minimal declines (or slight improvements) in non-production ecosystem services, an ASP production system would be a viable alternative to BAU. In that event, the ASP production system could help to preserve the cultural heritage of ranching in the region.

5. What are the primary uncertainties regarding the efficacy of ASP in overcoming limitations? (hypotheses)

Base your response on the Ecosystem Service(s) indicated above *(100 word limit)*

Provisioning *

Beef production: Much understanding about potentially economically favorable traits and behaviors of Criollo is currently anecdotal (see review in Anderson et al. 2015). Data collection in a wide range of spatial and temporal conditions is necessary to substantiate these anecdotal observations. Further, whether these traits and behaviors would translate into greater beef production and financial returns than BAU is currently unknown.

Regulating *

Biological regulation: The potential impact of ASP on state changes is currently unknown. Reduced consumption of grass could reduce state transitions; however, as honey mesquite seeds exploit ungulate dispersal (Havstad et al. 2006), extensive movements of Criollo could foster grass to shrub state transitions.

Air quality regulation: ASP influence on the number and arrangement of patches of bare, erodible soils is currently unknown.

Erosion protection: The universality of Criollo foraging distance from watering points is currently unknown.

Supporting *

Primary production: It is currently unknown whether Criollo traits and behaviors will overcome challenges related to spatial and temporal variability of primary production and past state changes, and translate into economically viable beef production.

The influence of ASP on spatial and temporal patterns of ANPP, in varying conditions, is currently unknown. How this influence will differ from the influence of BAU is currently unknown.

Biodiversity protection: Whether extensive foraging activities, into formerly under-utilized locations, will impart a different influence on wildlife than does BAU is currently unknown. How these differences will affect biodiversity is currently unknown.

Cultural and Amenity *

Cultural heritage: It is unknown whether BAU production limitations are causing a decline in public lands grazing and/or the regional cultural heritage of ranching. A combination of several factors may drive underutilization of BLM allotments. Allotments may support fewer animals than when AUMs were originally allocated, or ranchers may be exiting the business for reasons unrelated to economics.

6. Study design elements

a) What is the basic experimental design? *(200 word limit)* *

Criollo and BAU breed movements and foraging behavior will be measured using GPS collars with 5-minute interval fixes, during 1-2 week periods. Distribution and activity will be assessed in relation to multiple resource units, seasons, phenological phases, and years – and these assessment will be compared between Criollo and BAU breeds. The two cattle types will graze simultaneously so that they experience the same temporal variation. Spatial replicates will control for the dominance of ecological sites and current states. The study will initially be located at the JER, where pastures comprise the extensive size, rugged terrain, and ecological sites and states characteristic of pastures in the northern Chihuahuan Desert (MLRA 42). Additional study sites may be incorporated in the future.

In addition to tracking movements and landscape uses, we will concurrently measure herd productivity and economics, diet breadth, map-based state transitions, and NDVI-based primary productivity. If significant differences are detected in the amount and/or configuration of primary productivity in BAU vs. ASP pastures, we will consider developing a wind erosion model and/or setting camera traps to estimate wildlife biodiversity.

b) How will uncertainties pertaining to production and environmental benefits (#5) be tested? What are response variables, how will they be measured, at what spatial scales, with what replication, and over what time periods? Please justify responses.

c) What potentially useful response variables will be excluded and why?

Base your response on the Ecosystem Service(s) indicated above *(100 word limit)*

Provisioning

6 b) *

Beef production- Foraging distribution studies: GPS collar "fixes" will be recorded every five minutes. Activity in relation to resource units represented as 20 x 20 m pixels (landform, topography, vegetation types, ecological states, watering points, roads, and fencelines). Spatial and temporal distribution of cattle types will be compared.

JER herd measurements- Weight gain and maintenance, especially during drought (average daily gain per month). Supplemental feed use. Reproductive capacity (pregnancy, calving, and weaning frequencies). ~200 head.

Diet breadth studies- Stomach and fecal contents; DNA metabarcoding (Kartzinel et al. 2015).

Economic studies- Profit ($) and beef sold (lbs) from JER herd. Simulations of production and net income via grain-finishing.

6 c) *

Beef production: Profit ($) and beef sold (lbs) from grain-finished Criollo are currently excluded, because grain finishing equipment and infrastructure required for Criollo small body size and nonuniform conformation are not yet widely available.

Regulating

6 b) *

Biological regulation: Map-based state transitions in Criollo pastures vs. BAU breed pastures (Steele et al. 2012). Assessed decadally.

Air quality regulation: If significant differences in ANPP between BAU and ASP pastures are detected, wind erosion models based on changes in cover can be developed (Webb et al. 2014).

Erosion protection: GPS Collar data can be used to measure Criollo vs. BAU breed activity in relation to watering points.

6 c) *

Biological regulation: Measuring cattle dispersal of mesquite in Criollo vs. BAU breed pastures is currently excluded because cattle-seed dispersal relationships have been previously described and understood (e.g., Brown and Archer 1988), and they can be used to estimate current dispersal dynamics if necessary.

Air quality regulation: Monitoring dust emissions from BAU vs. ASP pastures is currently excluded because we do not yet have enough information to determine whether this level of detail is important or necessary.

Erosion protection: Monitoring vegetation and soil properties adjacent to watering points is currently excluded, because we do not yet have enough information to determine whether these ground-based data are important or necessary.

Supporting

6 b) *

Primary production: Spatial and temporal dynamics of ANPP of vegetation classes in BAU vs. ASP pastures, as estimated by satellite-based remote sensing (e.g., AVHRR NDVI) (Hunt et al. 2003). In addition, ground-based ANPP dynamics under ungrazed conditions in the 5 major vegetation states within the area have been measured since 1989 (Huenneke et al. 2001). Livestock stocking rates are generally low, but these existing long term ANPP measures provide a base control measurement of productivity. If needed, we could identify other large areas on the JER not grazed by livestock that could provide acreage for other control measurements of specific services.

Biodiversity protection: If significant differences in ANPP between BAU and ASP pastures are detected, camera traps can be set, with a likely focus on large native herbivores and carnivores.

6 c) *

Biodiversity protection: Monitoring soil microbial diversity, land bird diversity, and pollinators is currently excluded, because the ASP treatment is not expected to significantly influence habitat or resource variables for these taxa (see Coffman et al. 2014, Whitford and Bestelmeyer 2006). High spatial heterogeneity and processes occurring at spatial scales broader or finer than those of our experimental manipulations are expected to be dominant determinants of diversity patterns in these functional groups.

Cultural & Amenity

6 b) *

Cultural heritage: Initially, we do not plan to undertake measurements associated with cultural heritage, because we cannot reliably measure the processes sustaining or diminishing cultural heritage at the scale of the experiment.

6 c) *

Cultural heritage: Eventually, ranch solvency and persistence in relation to BAU vs. ASP may be measurable. However, such data would be available only after ASP is 1) confirmed to be a viable ASP system, and 2) adopted widely enough for meaningful study and comparison with BAU.

7. How will resulting data be used to improve management or rethink ASP approaches? (expected benefits) *(No word limit)* *

Livestock producers in the southwestern U.S. are faced with multiple, persistent challenges, including low and variable rainfall, spatial and temporal variation of primary production, and ecological state changes. Fencing and strategic placement of supplemental feed, water, and salt are typical management strategies in use to cope with these challenges (Bailey 2004). Incorporating heritage genetics into current practices may enhance producers' ability to cope with systemic variability and state changes.

If data reveal that Criollo can support or enhance economically sustainable beef production while causing minimal declines (or slight improvements) in non-production ecosystem services, an ASP production system would be a viable alternative to BAU.

In that event, USDA and state extension programs could provide support for producers to adopt ASP and invest in grain-finishing equipment and infrastructure that accommodate Criollo.

Alternatively, we may discover that ASP provides little economic advantage compared with BAU or that ASP production carries unrecognized costs to non-production ecosystem services, suggesting that alternative ASP strategies should be considered.

8. References (if used) *(No word limit)*

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