The Use of Virtual Fence Technology as a Management Tool for Beef Cattle

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2022 Montana Nutrition Conference and Livestock Forum

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Research Group

Oregon State University Scientists:

David Bohnert
Juliana Ranches
Dustin Johnson

USDA-ARS Scientists:

Chad Boyd
Kirk Davies
Rory O'Connor

Presentation Overview

1. Introduction

2. Virtual Fence (VF) Research Highlights:

Effects of virtual fence monitored by global positioning system on beef cattle behavior (Ranches et al., 2021)

Virtual Fencing Effectively Excludes Cattle from Burned Sagebrush Steppe (Boyd et al., 2022)

Using Virtual Fencing to Create Fuel Breaks in the Sagebrush Steppe (Boyd et al., 2022)

3. Ongoing VF Studies:

Fine Fuels management

Riparian study

Introduction

- In modern agricultural systems, **multiple types of fences** are used to contain and manage livestock.
- Conventional fences are static tools that are very **effective in controlling animal ingress or egress** but **fail** to offer managers the flexibility they need to **optimize the physiological requirement of the vegetation with the nutritional needs of foraging animals** (Anderson, 2007)
- Traditional fencing is often delayed by procedural and logistical barriers (e.g., NEPA, archeological clearances, contracting, labor availability, etc.)

Introduction

- The most common types of fences are barbed wire & electric, which are **often time-consuming to build and maintain, and are costly** (Bishop-Hurley et al., 2007).

- Expenses related to traditional fence are increasing (supplies and labor)

Recent 2022 bids for new fence in rangeland and forest environments in Oregon:
$13,000 to $40,000 per mile

Cross-fencing to subdivide pastures in Montana:
10,240 acres into 16 even-sized 640-acre pastures =
the initial installation and labor cost of four-strand barbed wire is **$8,290/mile*** (Knight et al., 2011)
*not considering incentives/support

Introduction

- Recent technology using **behavioral modification** based on GPS-activated collars
- ***Virtual fence:*** is a structure serving as an enclosure, a barrier, or a boundary **without** a physical barrier

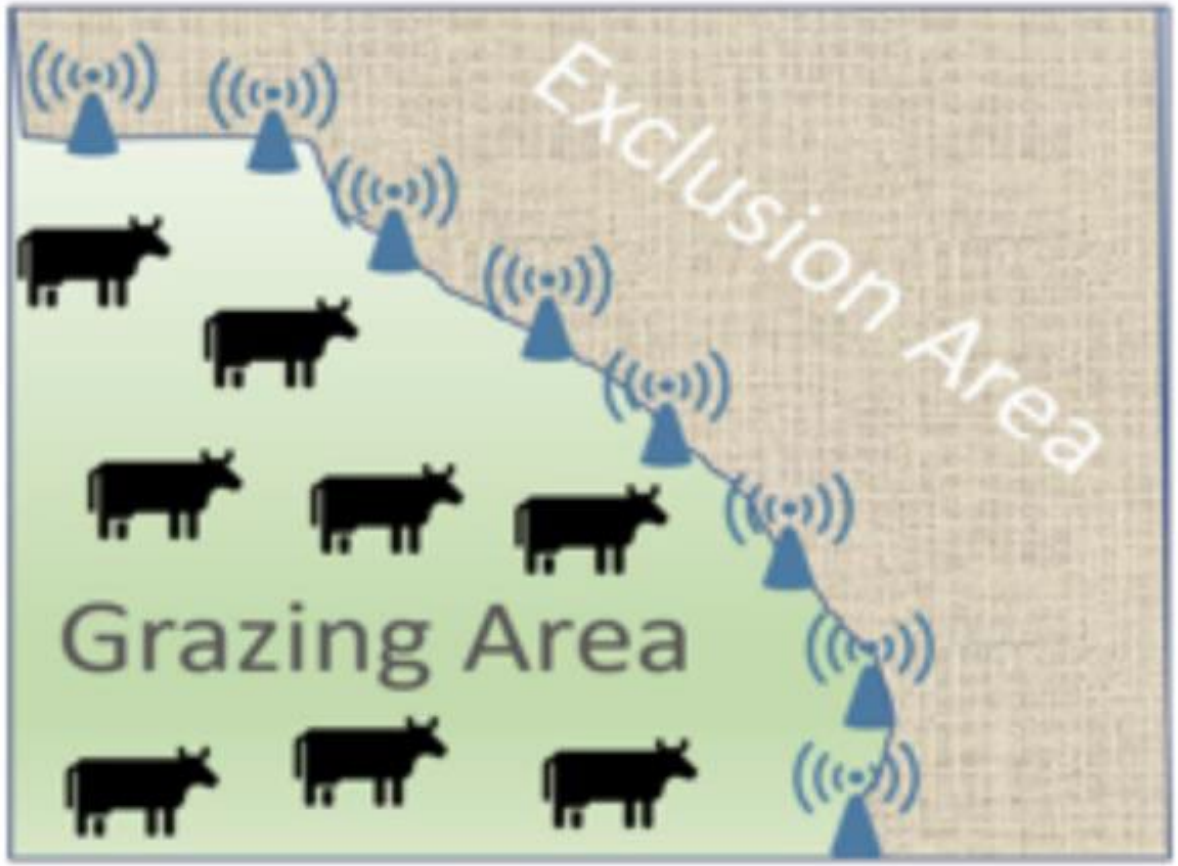
→ ***Virtual fencing (VF)***

- ❑ Less expensive
- ❑ Less logistically challenging
- ❑ Less labor intensive
- ❑ **Management to the animal level**

Introduction

"Fenceless" Fencing is not a new concept, but technological progress has improved the feasibility

Proximity Sensing
(ground-based transmitters)

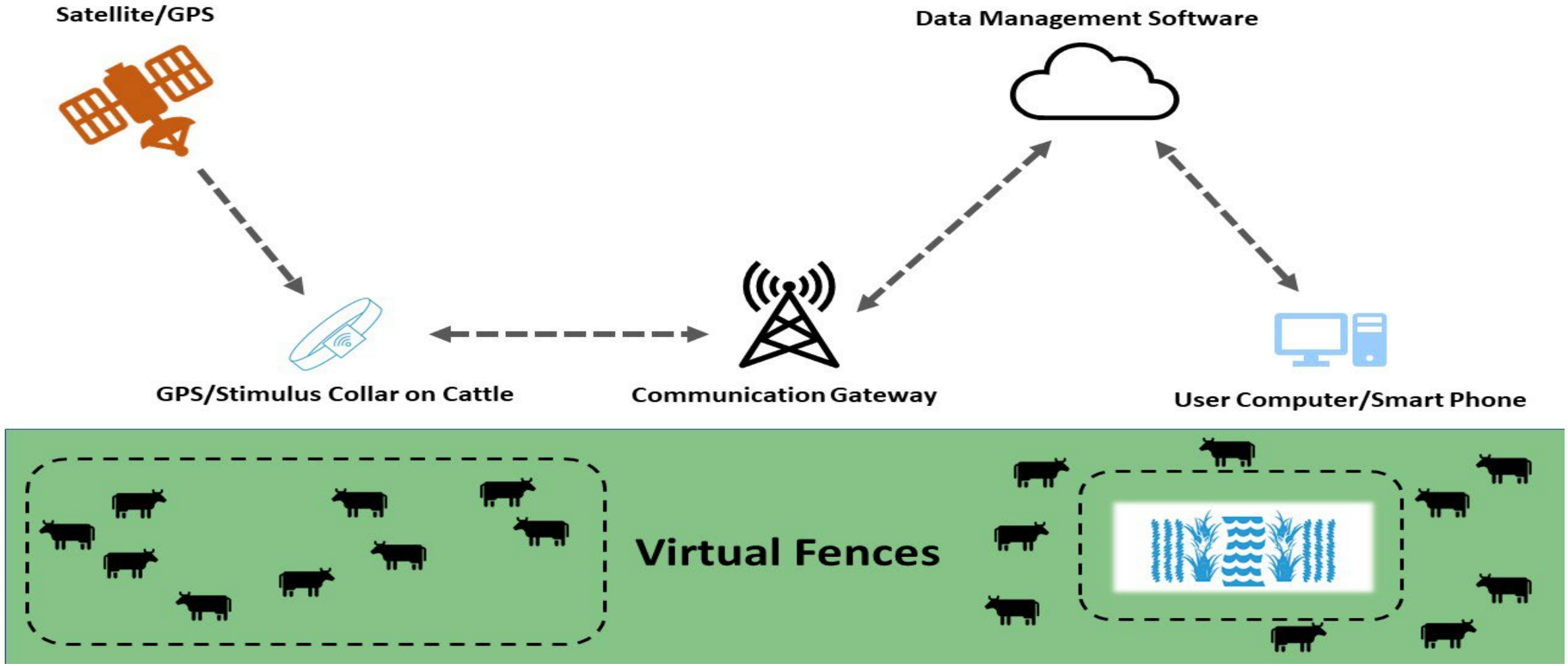


GPS Location

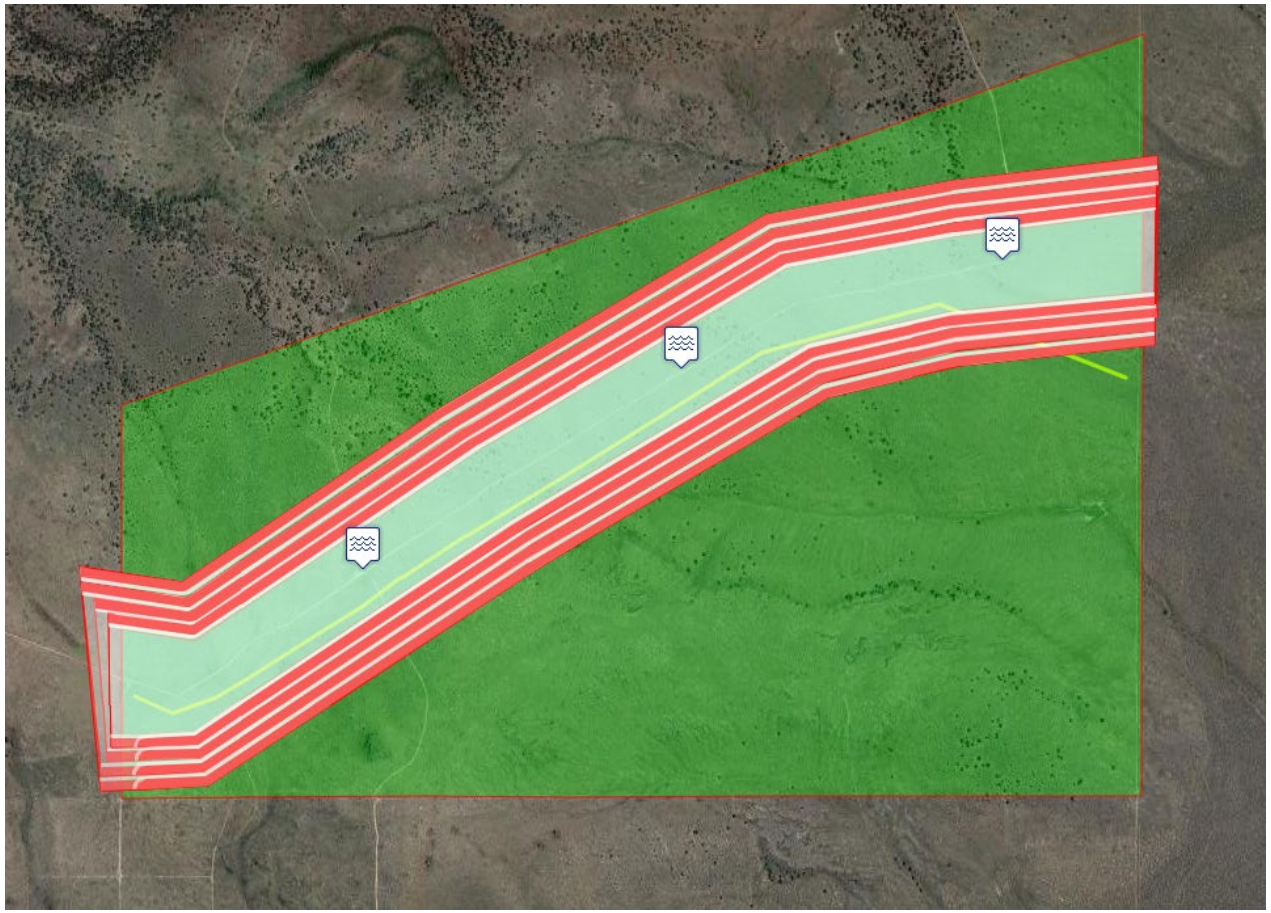
Anderson, 2007

Introduction

- ***Virtual fence:*** is a structure serving as an enclosure, a barrier, or a boundary **without** a physical barrier.



Introduction



- Designated boundaries in a given area
- GPS collars give auditory and sensory cues to the cattle if cattle trespass the determined boundary.
- ***Conditioning association to the auditory cue.***
- ***Management to the individual level.***

Introduction

Virtual Fence Uses:

- Protect grazing restriction areas – Post fire
- Protect sensitive areas – Riparian areas
- Cattle location and monitoring
- Pasture subdivision, land utilization
- Avoid toxic plants consumption
- Targeted grazing

- ***Virtual Fence Projects at EOARC:***
  1. ***Behavior study***
  2. ***Burned area study***
  3. ***Fire break study***

Objective and Hypothesis

We hypothesized that the use of VF collars would be an effective method to contain cattle in a specific area or/and prevent cattle from entering a designated area. Furthermore, we hypothesized that the use of VF collars would not negatively impact cattle behavior.

Thus, the objective of this study was to evaluate the efficacy of VF as well as the behavior of naïve cows when fitted with VF collars for the first time.

Ranches et al., 2021

Material and Methods

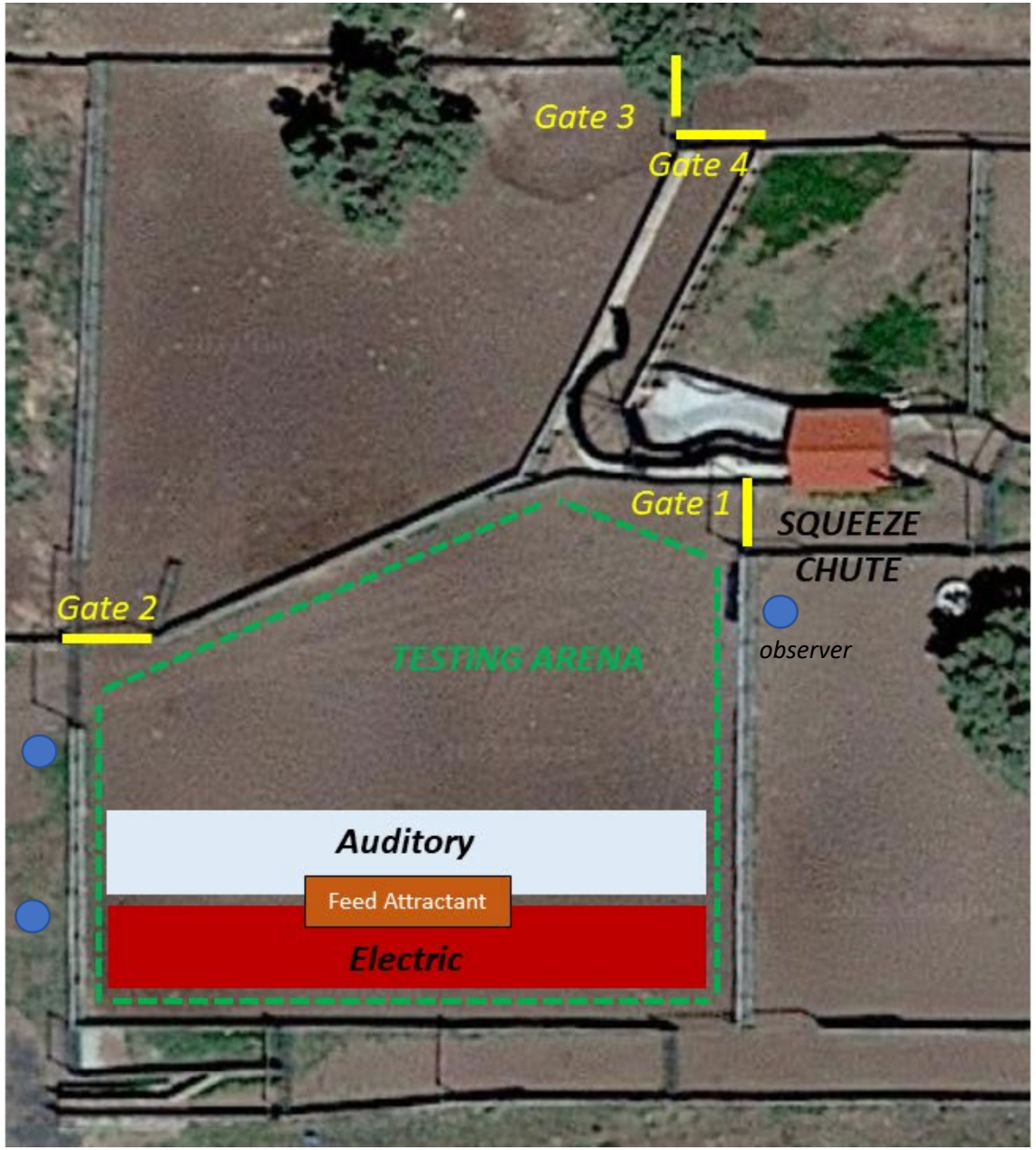
1. *Animal Selection and Handling:*

- Cows (*n*= 11) selected for this study were never fitted with VF collars and therefore were considered naïve to the technology.
- For behavioral evaluation, each cow was fitted with a unique VF collar (Vence Corp. Inc. San Diego, CA) for the duration of the study.
- At the end of data collection at the testing arena, cows were collared for 8 days and maintained in a VF area as a group for collection of auditory and electric cues

Material and Methods

2. *Virtual Fence and Testing Arena*:

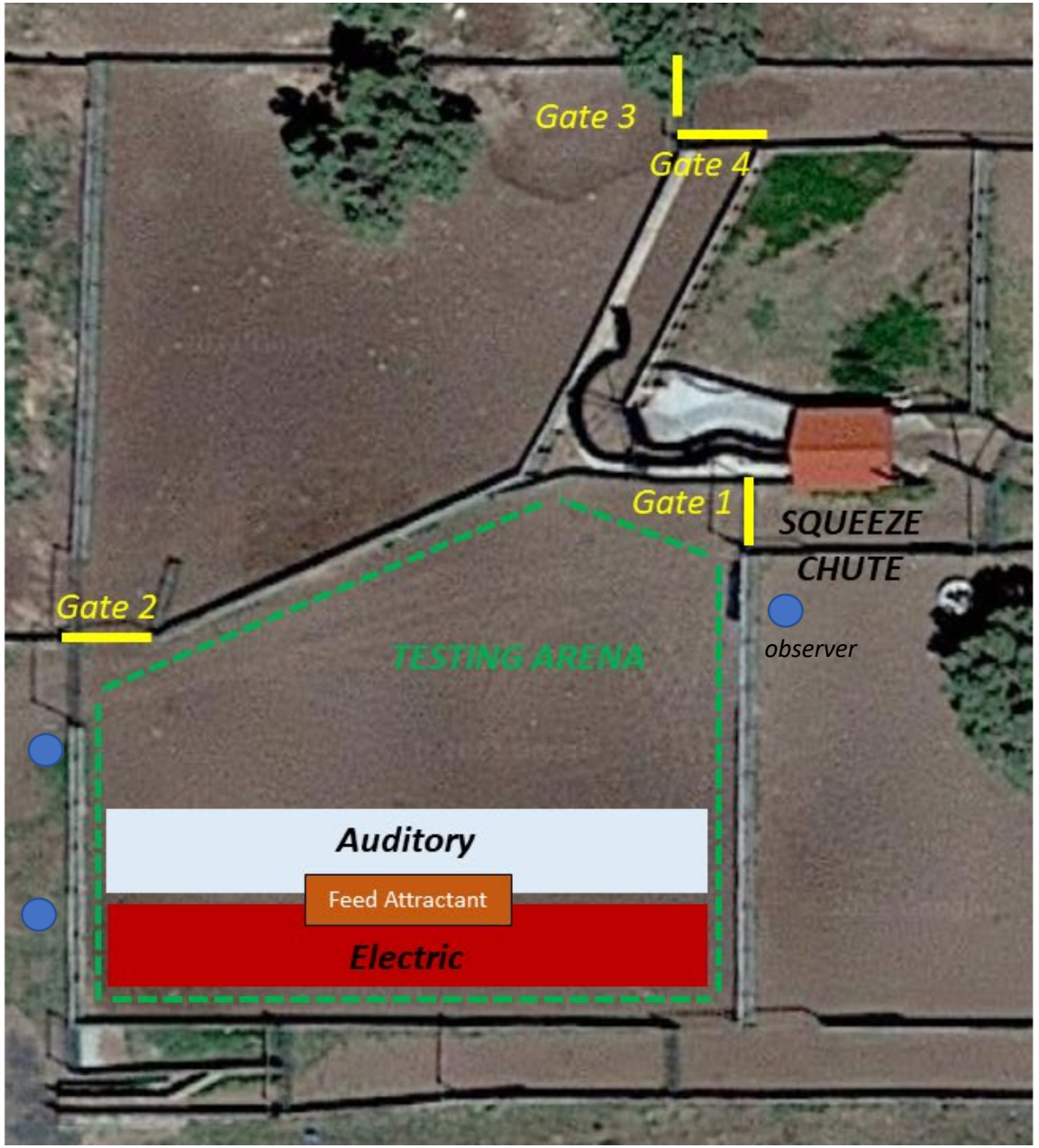
- The testing arena was created using Herd Manager (Vence Corp. Inc. San Diego, CA) according to GPS coordinates.
- The VF contained two management zones, one where the auditory stimulus (AS) was applied and another one where the electric stimulus (ES) was applied.



Material and Methods

3. Data Collection:

- Data were collected **individually for each cow over 5 runs** of 10 minutes each.
- A bale of alfalfa (*Medicago sativa*) hay was placed approximately in the middle of the VF management zone, to serve as a **feed attractant**.



Material and Methods

3. Data Collection:

- **Chute score:**

1 = calm, no movement to 2 = restless shifting; 3 = constant shifting with occasional shaking of the chute; 4 = continuous movement and shaking of the chute; and 5 = violent and continuous struggling.

- **Chute exit velocity (m/s)**
- **Collar fit score:** upon 30 s of observation;

1 = unalarmed and unexcited, walking slowly; 2 = slightly alarmed and excited, moving moderately quickly; 3 = moderately alarmed and excited, moving quickly; 4 = very alarmed and excited, moving quickly and shaking head; and 5 = extremely alarmed and excited, moving quickly, shaking the head, and jumping

Material and Methods

3. Data Collection:

- **Latency to approach feed attractant:** recorded for all cows in all runs by one individual using a stopwatch (Versa, Fitbit; San Francisco, CA).

Material and Methods

3. Data Collection:

- **Cow location and behaviors:** collected using focal point observations every one minute.
- **Auditory and electric stimuli data:** were collected from VF collars. The VF collar logged the date, time, GPS location, and any cues applied.

Category	*Behavior*	*Behavior Description*
Feeding	Eating	Cow eats attractant (hay)
	Browsing	Cow eats grass/shrubs present in the test arena
Locomotion	Idling	Cow does not perform any behavior - Standstill
	Walking	Cow walks/wanders in the test arena
	Head shaking	Cow shakes head while standstill
Agonistic, non-desirable	Walking; head shaking	Cow walks and moves head non-natural movement
	Running/trotting	Cow runs/trots in the test arena
	Running/trotting; head shaking	Cow runs/trot and moves head non-natural movement
	Jumping	Cow jumps in the test arena
	Jumping and head shaking	Cow jumps and shakes head simultaneously
	Bucking and running	Cow bucks and runs

Results

Item	*Run 1*	*Run 2*	*Run 3*	*Run 4*	*Run 5*	*Largest SEM*	*P-value*
	Collar off	*Collar on*			*Collar of*		
Chute score	1.40	1.25	1.30	1.30	1.40	0.109	0.85
Chute exit velocity, m/s	2.10	1.45	1.80	1.85	1.90	0.244	0.37
Collar fit score	1.45[b]	3.65[a]	1.60[b]	1.30[b]	1.25[b]	0.197	< 0.001

[a, b] Means within rows with different superscripts differ.

Results

Item	*Run 1*	*Run 2*	*Run 3*	*Run 4*	*Run 5*	*Largest SEM*	*P-value*
	Collar off	*Collar on*			*Collar of*		
Latency to approach feed, s	287	283	455	511	418	73.20	0.12
Time spent in VF, %	62.7^{a}	22.7^{b}	18.6^{b}	12.2^{b}	$33.6^{a,b}$	8.766	< 0.01

$^{a, b}$ Means within rows with different superscripts differ.

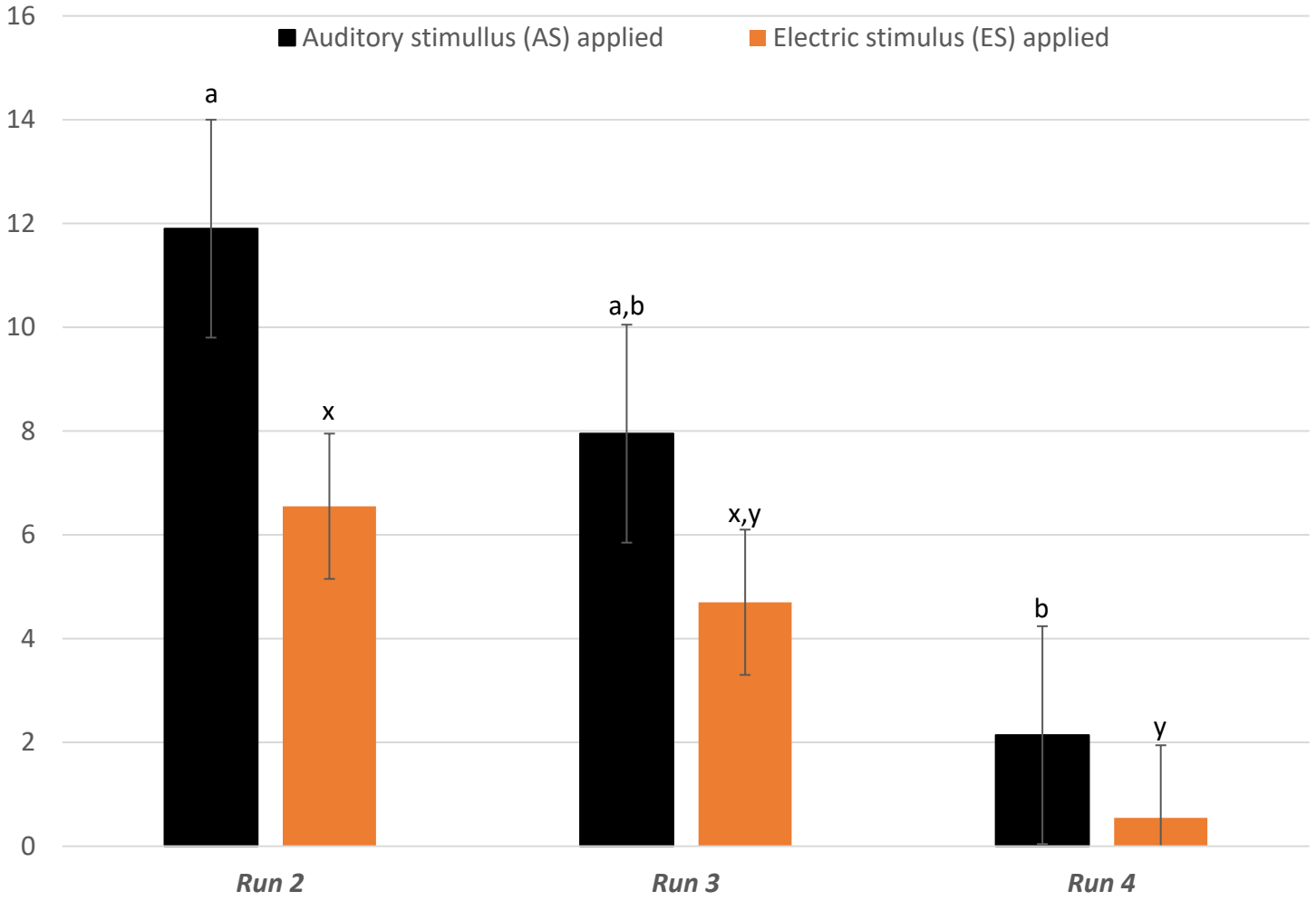
- During run 5, if a cow did not attempt to reach the feed, it was encouraged to reach the feed at the end of the run. All cows successfully reached the feed.

Results

Behavior	Run 1	Run 2	Run 3	Run 4	Run 5	Largest SEM	P-value
	Collar off	Collar on			Collar off		
Eating, %	**47.7^{a}**	**3.85^{b}**	**0.955^{b}**	**1.34^{b}**	**24.0^{a,b}**	**6.943**	**< 0.001**
Browsing, %	10.8	5.60	12.0	6.65	19.9	5.09	0.30
Idling, %	**21.9^{c}**	**52.3^{a}**	**54.9^{a}**	**57.8^{a}**	**36.6^{a,b,c}**	**6.95**	**< 0.01**
Walking, %	15.9	17.8	24.9	26.0	18.8	4.01	0.30
Head shaking, %	0.466	3.50	0.970	1.70	0.250	1.018	0.17
Walking; head shaking, %	0.485	4.01	0.888	2.83	0.252	1.240	0.15
Running/trotting, %	0.00	1.14	0.92	0.88	0.00	0.962	0.85
Running/trotting; head shaking, %	**0.00^{b}**	**5.54^{a}**	**1.60^{b}**	**0.800^{b}**	**0.00^{b}**	**0.815**	**< 0.001**
Jumping, %	0.00^{b}	1.08^{a}	0.232^{b}	0.235^{b}	0.00^{b}	0.240	0.01
Jumping and head shaking, %	0.00^{b}	1.86^{a}	0.927^{a}	0.00^{b}	0.00^{b}	0.405	< 0.01
Bucking and running, %	0.00^{b}	1.25^{a}	0.232^{a,b}	0.00^{b}	0.00^{b}	0.307	0.02

$^{a, b,c}$ Means within rows with different superscripts differ.

Results



[a, b] *Means with different superscripts differ for AS.*

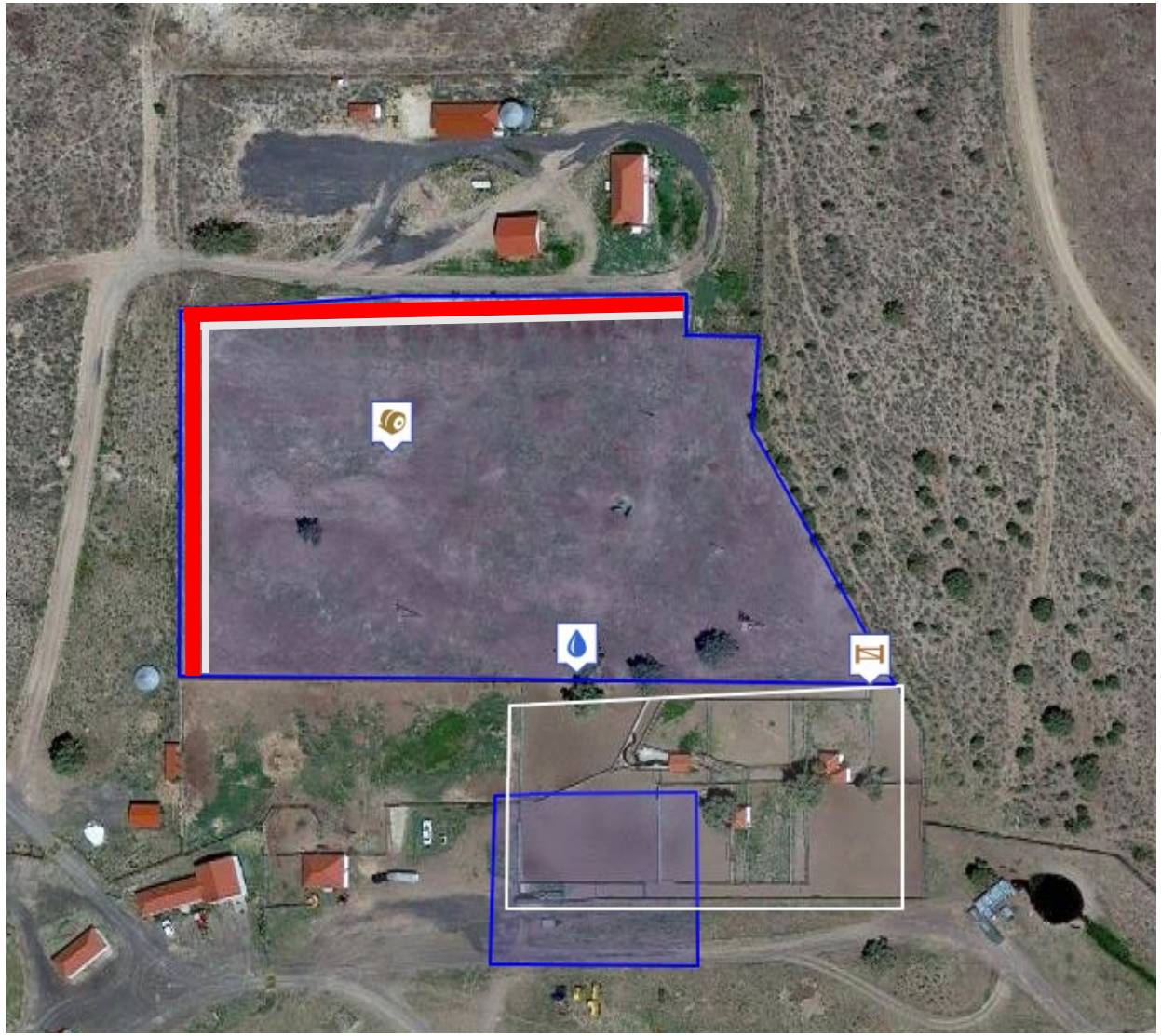
[x,y] *Means with different superscripts differ for ES.*

- Auditory (AS) and electric (ES) stimuli applied to cows during runs 2, 3, and 4 followed the same pattern and were positively correlated in all runs ($r = 0.88$; $P < 0.001$).

Results

Dry Lot Phase:

- The VF was created following the perimeter of the pasture; in L-shaped management zone. The management zones were created from the traditional fence inward to the pasture.
- The AS management zone was 5 m wide and the ES management zone was 15 m wide, therefore combined management zones were 20 m wide.



Results

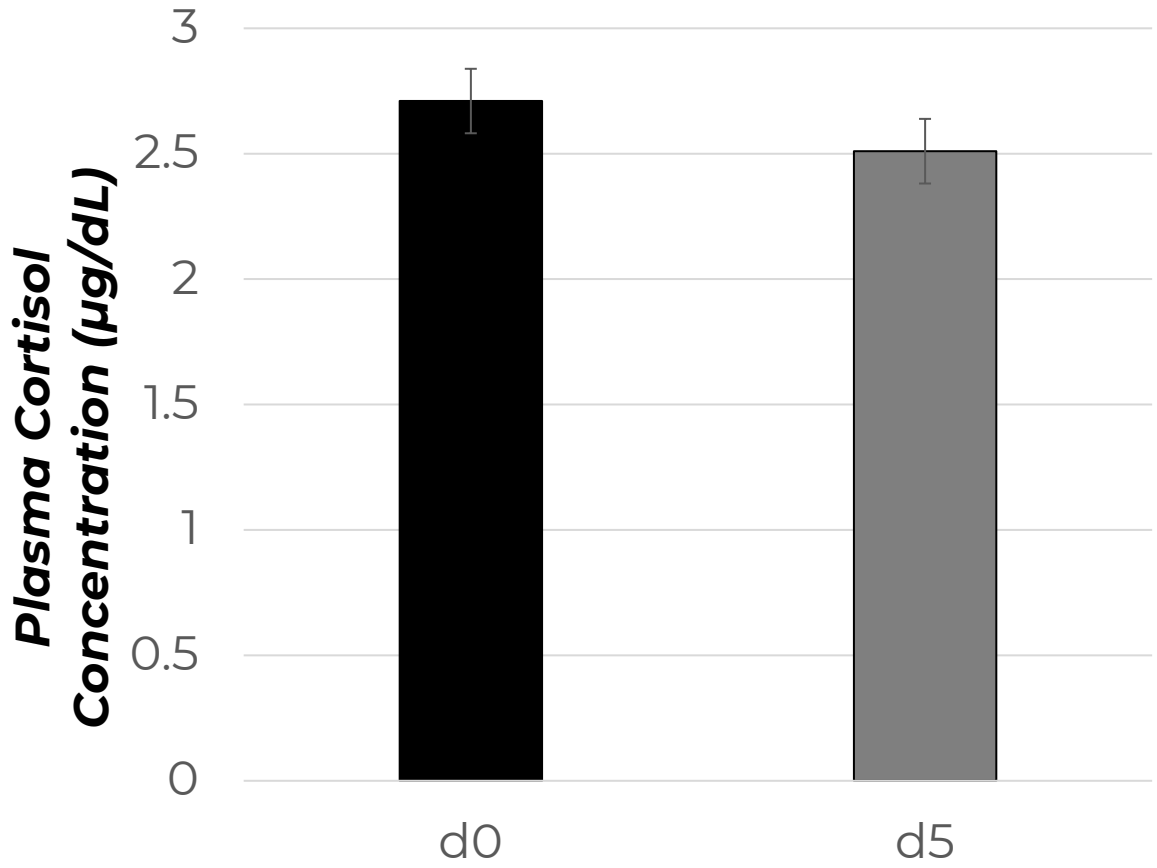
	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Largest SEM	P-value
Auditory stimulus, count[1]	24.60[a]	17.20[a,b]	13.20[a,b]	14.50[a,b]	14.00[a,b]	7.80[b]	12.60[b]	9.90[b]	2.79	0.002
Electric stimulus, count[1]	14.60[a]	2.60[b]	2.70[b]	1.90[b]	1.90[b]	0.90[b]	1.60[b]	0.545[b]	0.687	<0.0001

Dry lot Phase:

- Cow were marinated in the dry lot for 8 days.
- Cows had free access to feed and water in the center of the pasture.

Results

- ***How do electric cues affect cattle physiology?***



- Blood samples collected for cortisol analysis (***stress hormone***) when cows were fitted with VF collars for the first time (d0) and again after the training phase (d5); *P = 0.13*

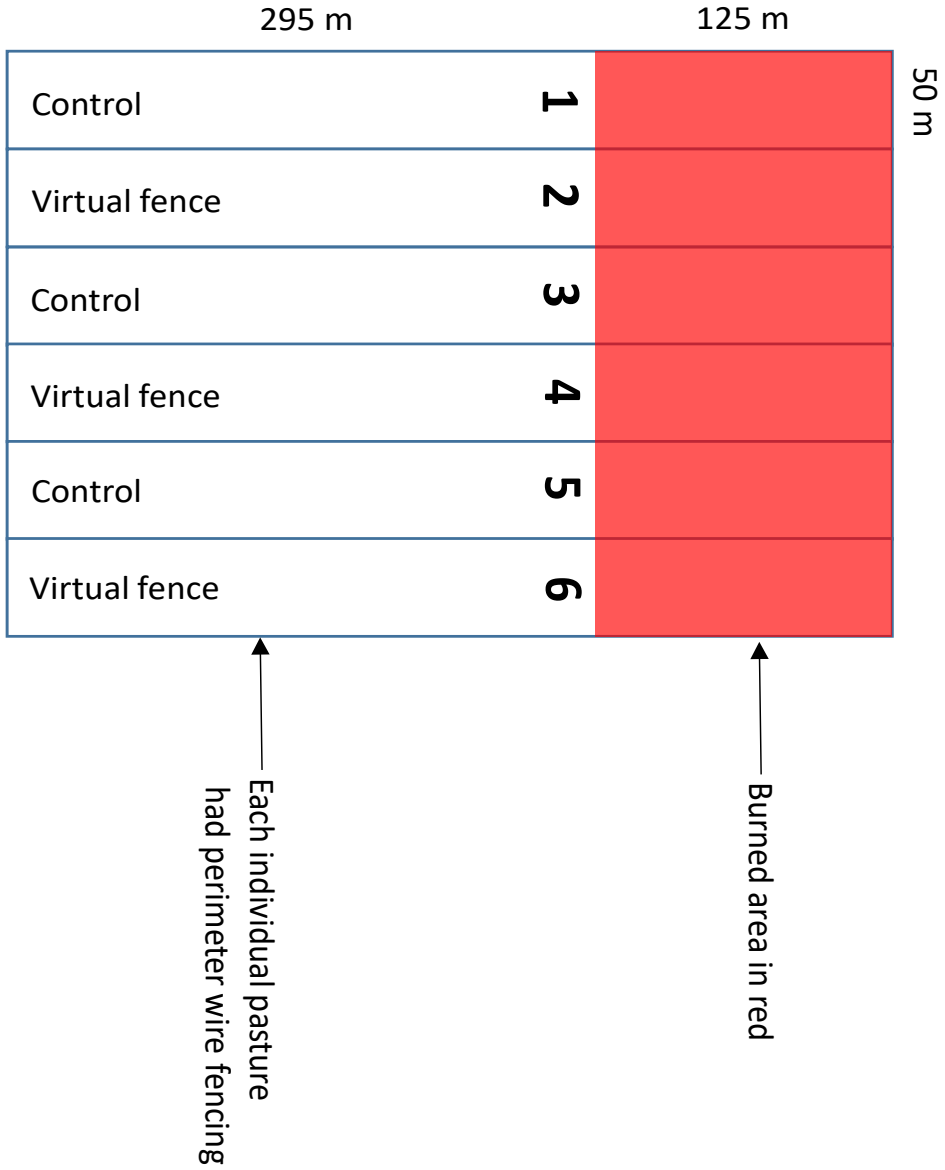
Ranches at el., *in prep*

Objective

Determine the efficacy of virtual fence technology for reducing cattle use of recently burned sagebrush steppe

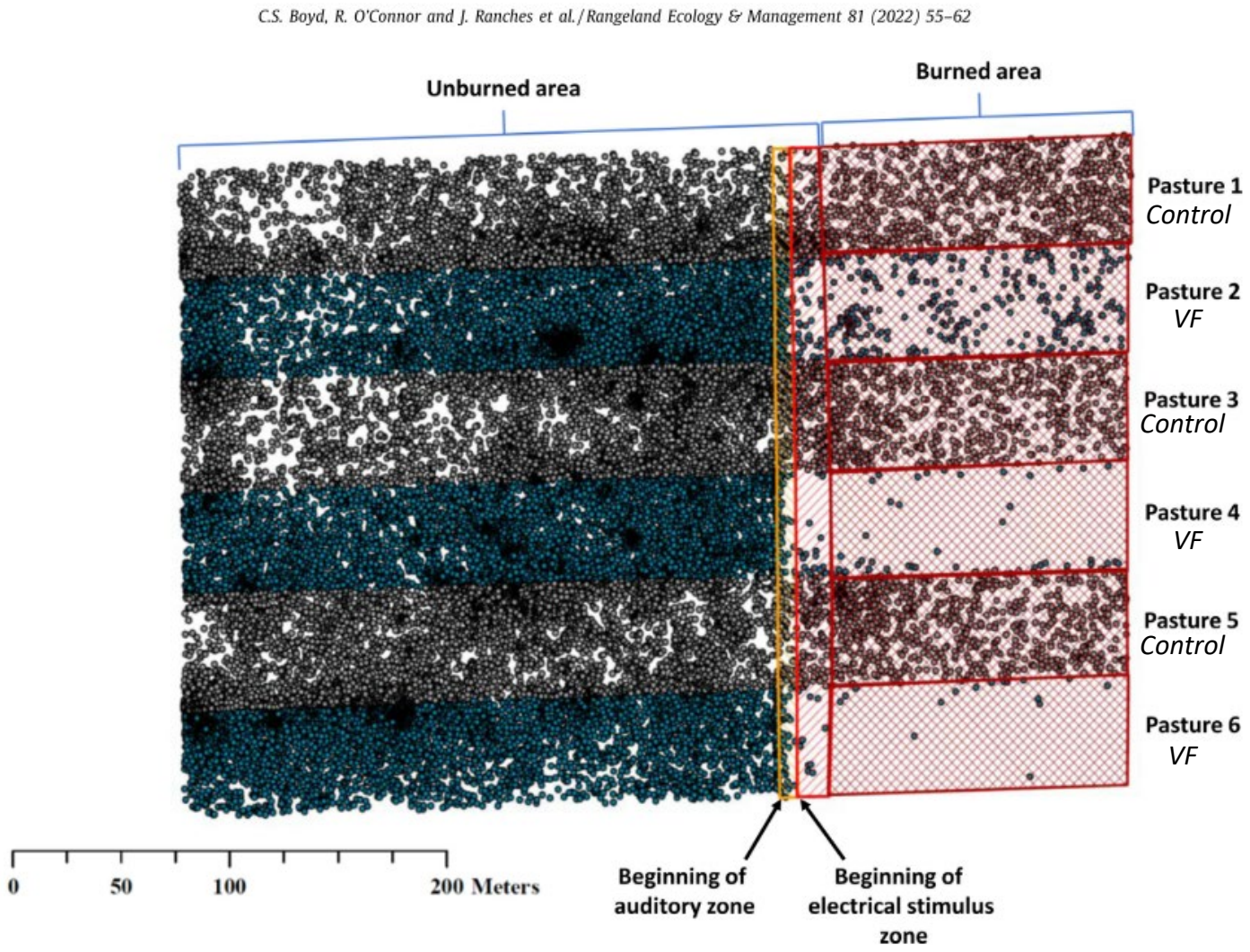
Boyd et al., 2022

Material & Methods



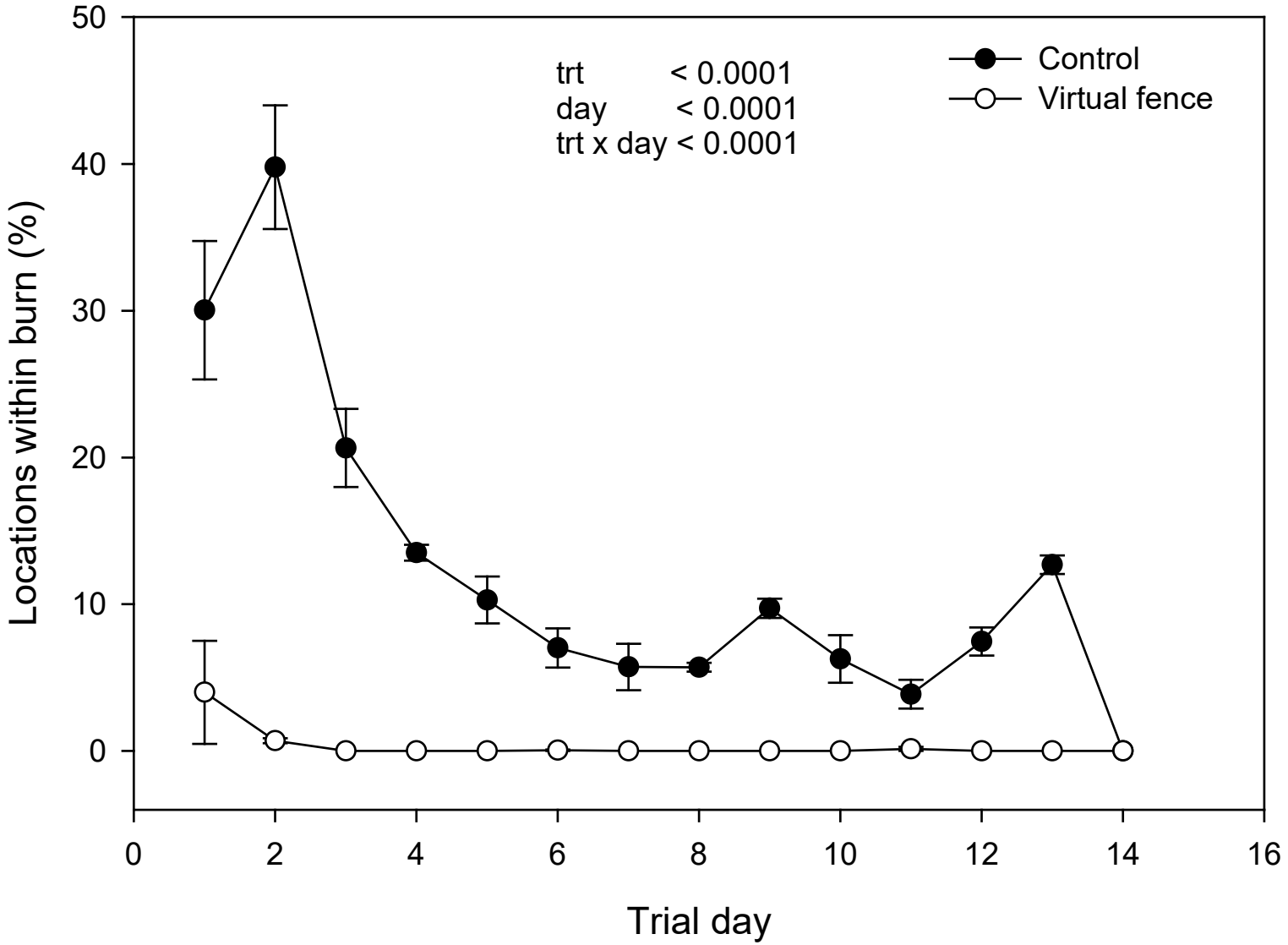
- The study was conducted in June of 2020 in a Wyoming Big Sagebrush Plant Community at the Northern Great Basin Experimental Range "Butte" in southeast Oregon
- A total of **6 pastures** were used. The perimeter of each individual pasture was fenced with 5 strand barbed wire fence
- Approximately **30 percent of each pasture had been burned** the previous fall (red area in the diagram)
- Each pasture had **3 mature dry cows for a period of 14 days**
- Cattle locations were monitored **at 5 minute intervals** for the duration of the trial

Material & Methods



- For **Control pastures**, collars were left in "tracking" mode and no auditory or electric stimulus was delivered.
- For **virtual fence pastures**, there was a **30 m wide pressure zone** (management zone) within the unburned subplot, extending out from the its junction with the burned subplot. Within this zone, animals encountered **a 20 m wide auditory** alert zone within which electronic beeps played on the collars speaker, and this was followed by **a 10m wide electric stimuli zone.**

Results

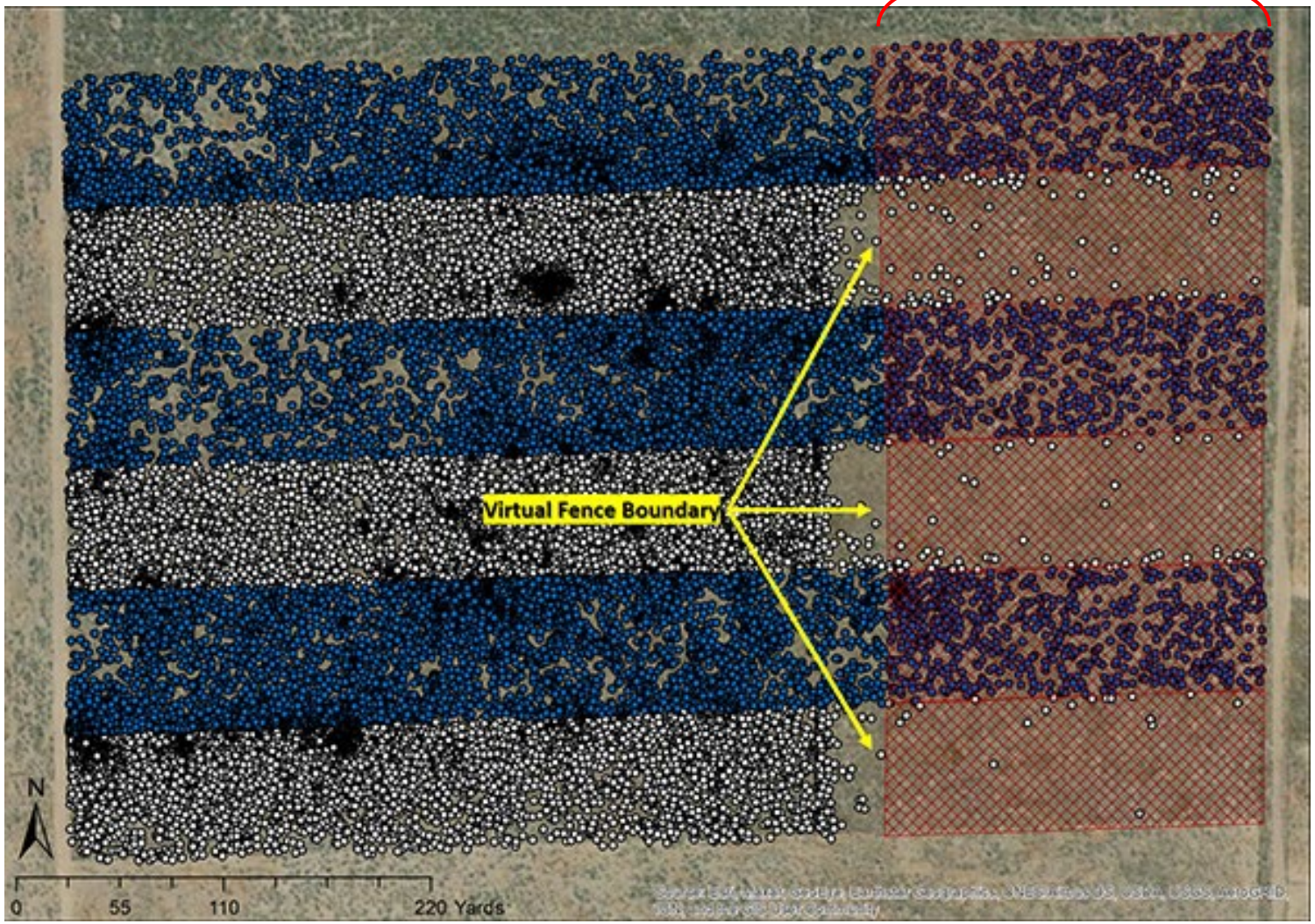


- Cows assigned to the control treatment (VF off) spent **up to 40% of their time within the burned area**, resulting in a **heavy forage utilization of the burned area (approximately 70%).**

Cows assigned to the VF treatment spent less time in the burned area, **spending approximately 4% of their time** in the burned area on the first day in the pasture.

Cows assigned to VF treatment were rarely recorded in the burned area, thereafter, **resulting in negligible forage utilization of the burned area** for this group of approximately < 3%.

Results



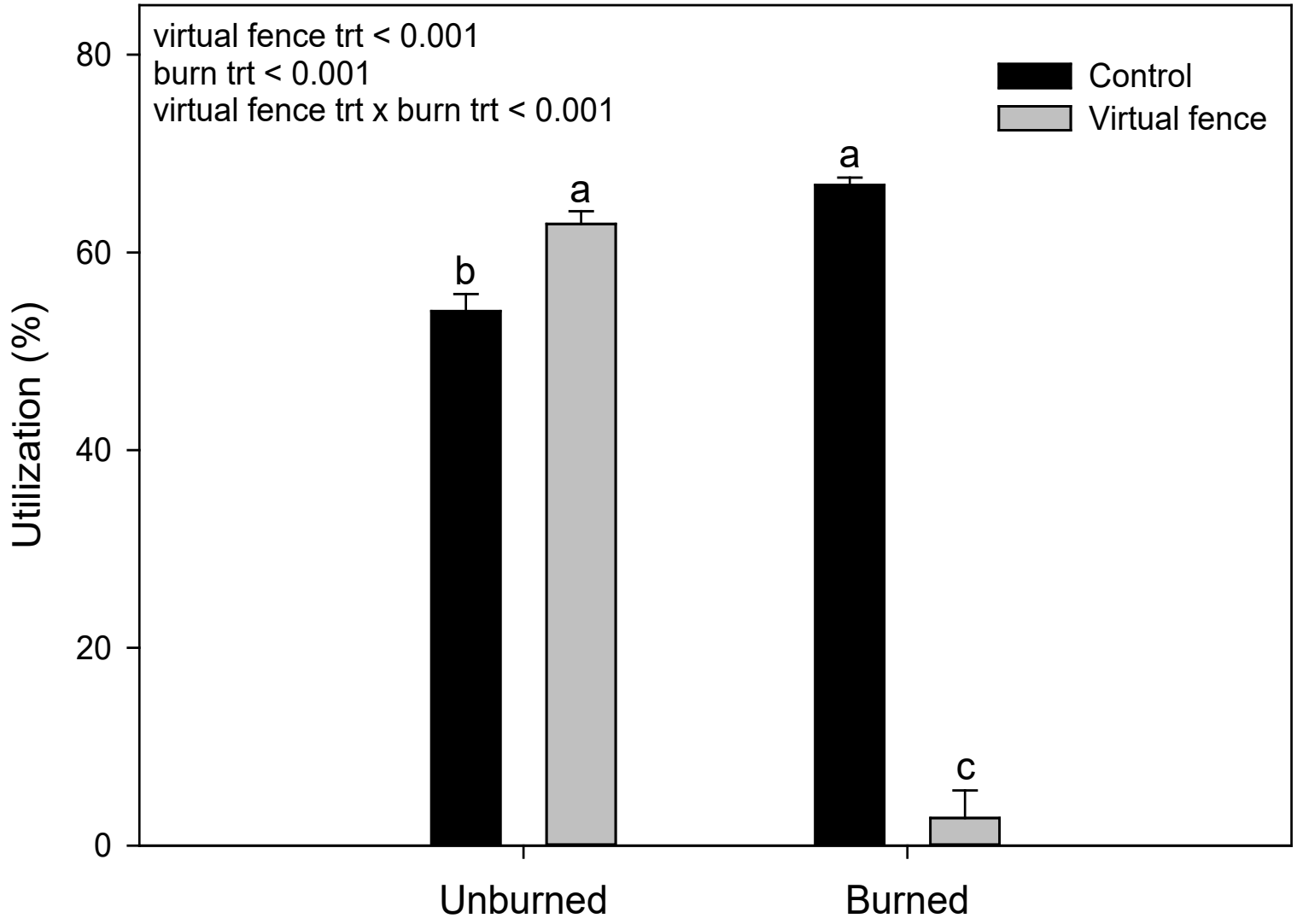
Each dot represent cow location during the study:

Blue dots = control cows,

VF collars **off**

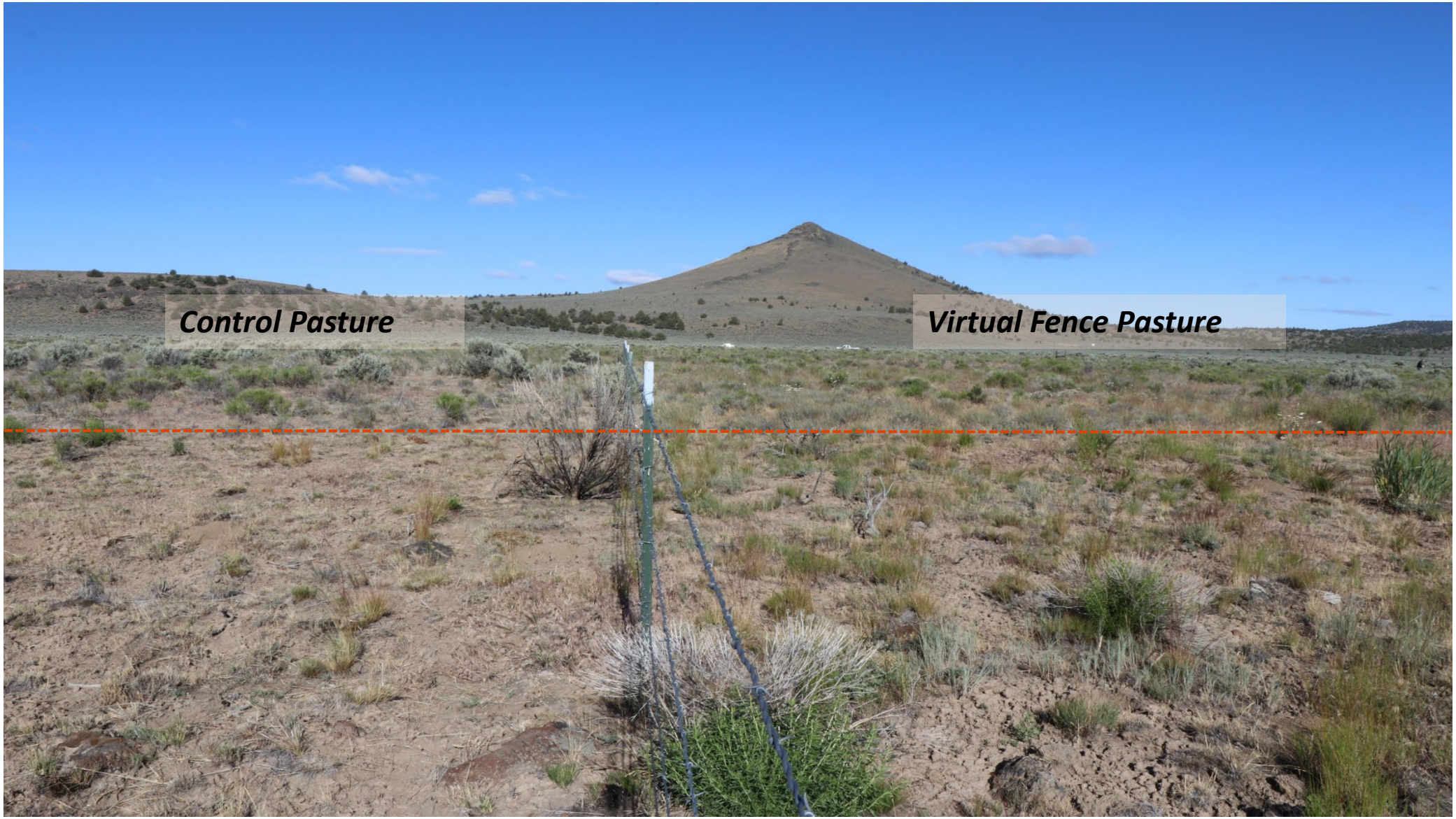
White dots = treatments cows, VF collars **on**

Results


virtual fence trt < 0.001
burn trt < 0.001
virtual fence trt x burn trt < 0.001
Control
Virtual fence
Utilization (%)
80
60
40
20
0
b
a
a
c
Unburned
Burned

Results

Visual comparison of burned area between control and VF pastures

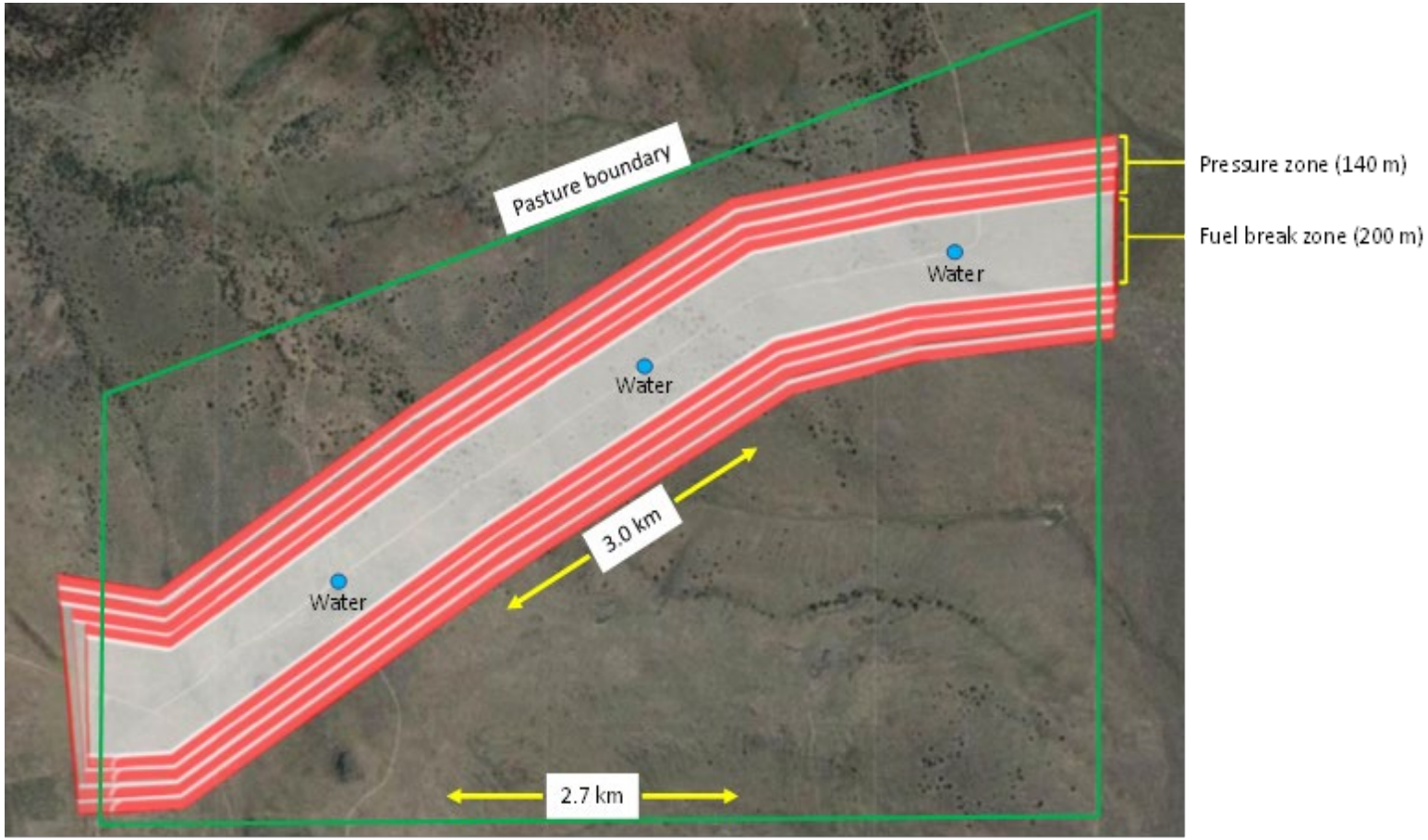


Objective

Determine the efficacy of virtual fence technology to reduce fuel load in a predetermined location – To create a fire break

Boyd et al., 2022

Material and Methods



- 42 mature Angus × Hereford cows; **26 pairs & 16 dry** – Only cows had collars
- Virtual fence set up as **multiple "one-way gates"**
- Worked with water locations to improve odds of success
- Target **forage utilization** was a minimum of **45%**
- Cows grazed for approximately 1 month.

Results


Grazing / Corvallis - America/Los Angeles 9:44:16 PM
HERD: FuelBreakHerd TIME: 5/28/2021, 8:00:00 AM - 6/27/2021, 8:00:00 AM
CATTLE
PADDOCK
LANDMARK
CALENDAR
Map
Satellite
Latitude, Longitude
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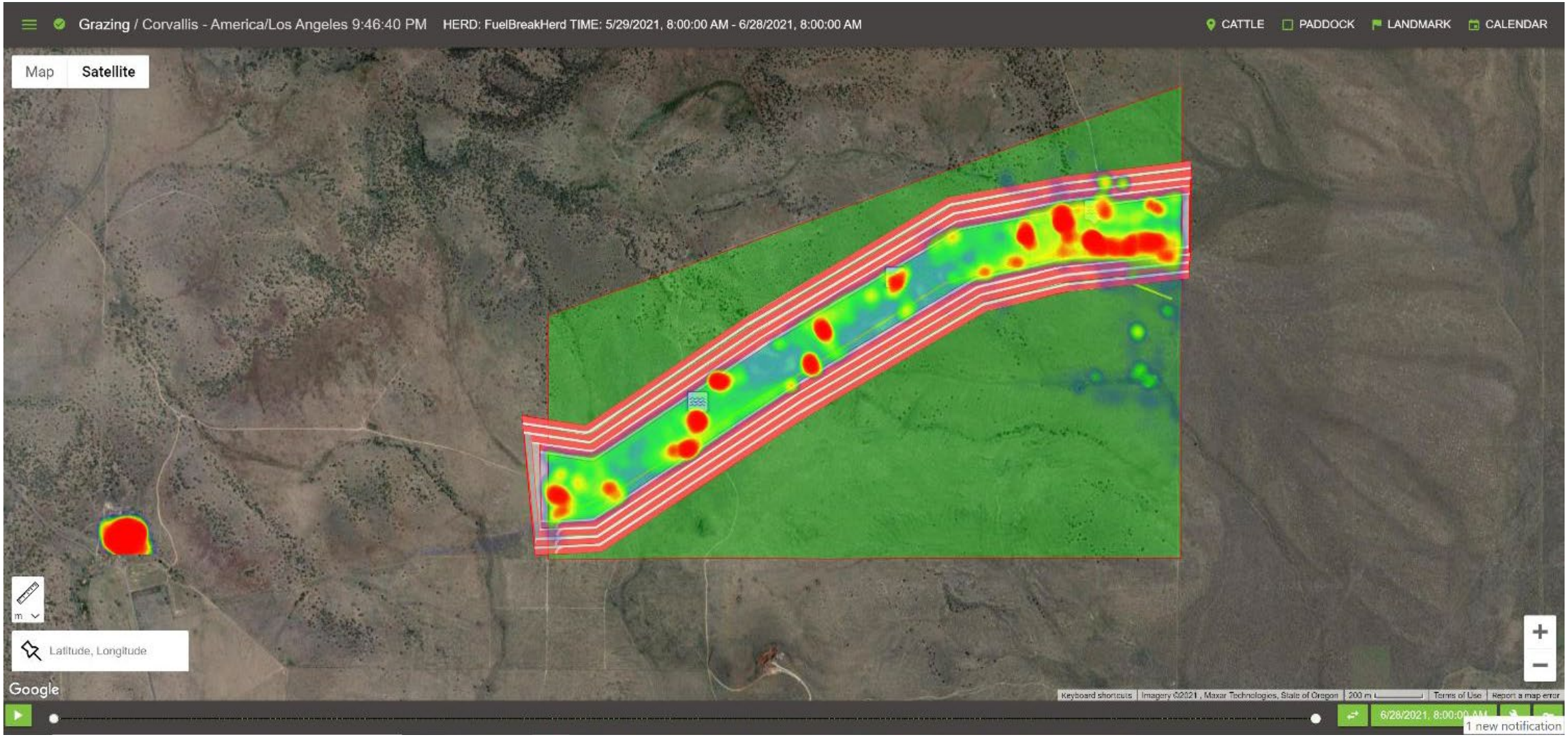
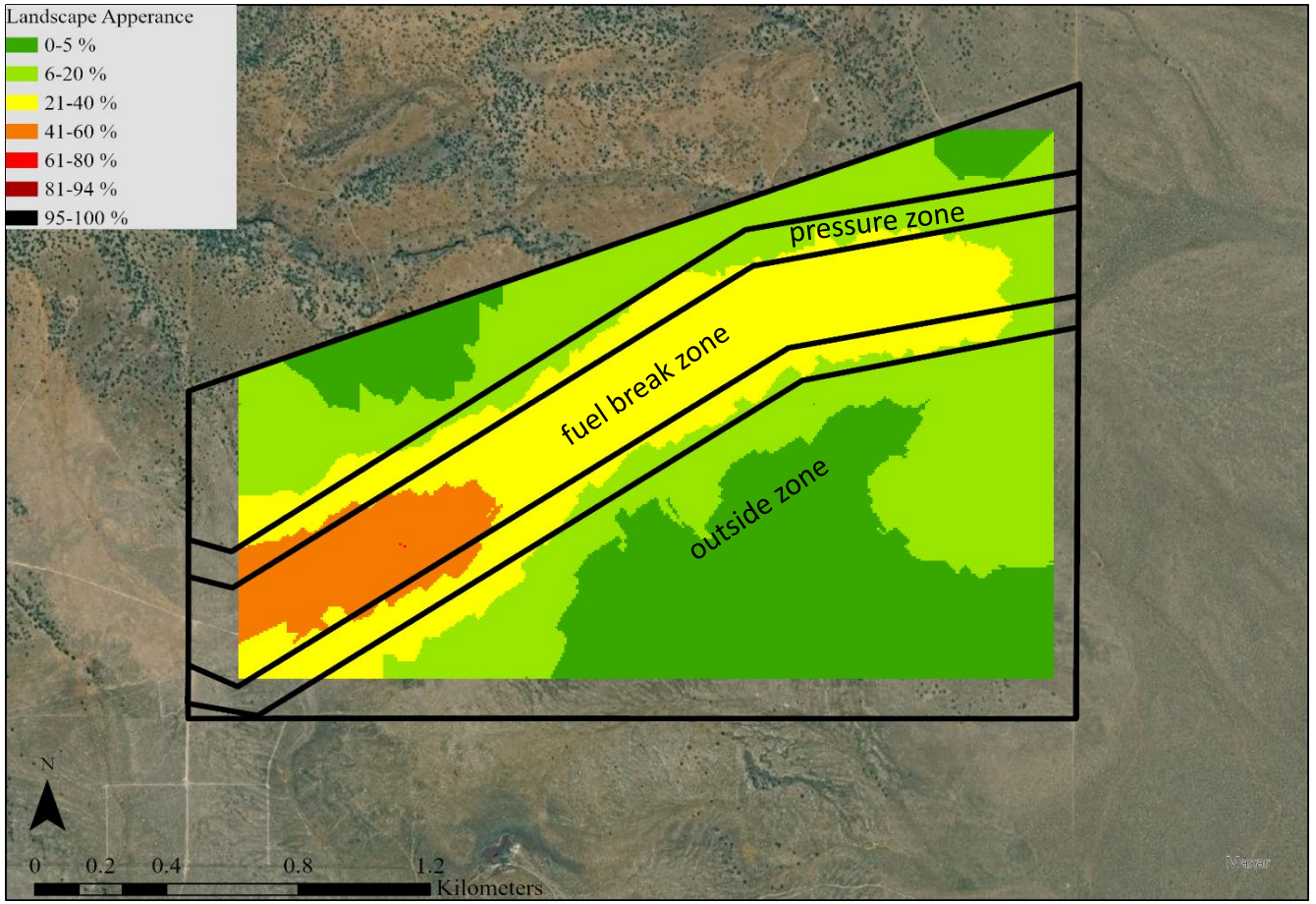
6/27/2021, 8:00:00 AM

Results


Grazing / Corvallis - America/Los Angeles 9:46:40 PM
HERD: FuelBreakHerd TIME: 5/29/2021, 8:00:00 AM - 6/28/2021, 8:00:00 AM
CATTLE
PADDOCK
LANDMARK
CALENDAR
Map
Satellite
Latitude, Longitude
Google
6/28/2021, 8:00:00 AM
1 new notification

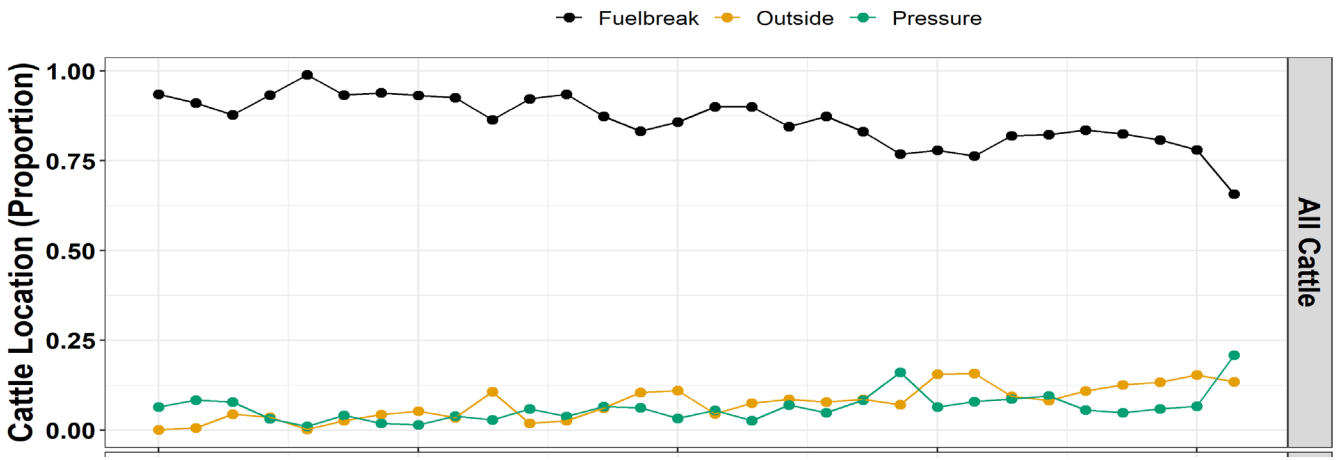
Results



- Post-trial utilization and post-trial standing crop of herbaceous forage differed by location ($p < 0.001$) and all locations differed from each other ($p < 0.05$).
- **Post-trial utilization averaged 48.5 ± 3.7%, 11.8 ±3.0%, and 5.5 ± 0.7%** for fuel break, pressure zone, and outside locations, respectively
- Post-trial standing crop for the fuel break, pressure zone, and outside locations was **405.9 ± 21.0, 533.3 ± 23.9, and 697.4 ± 40.2. kg/ha**, respectively.

Results

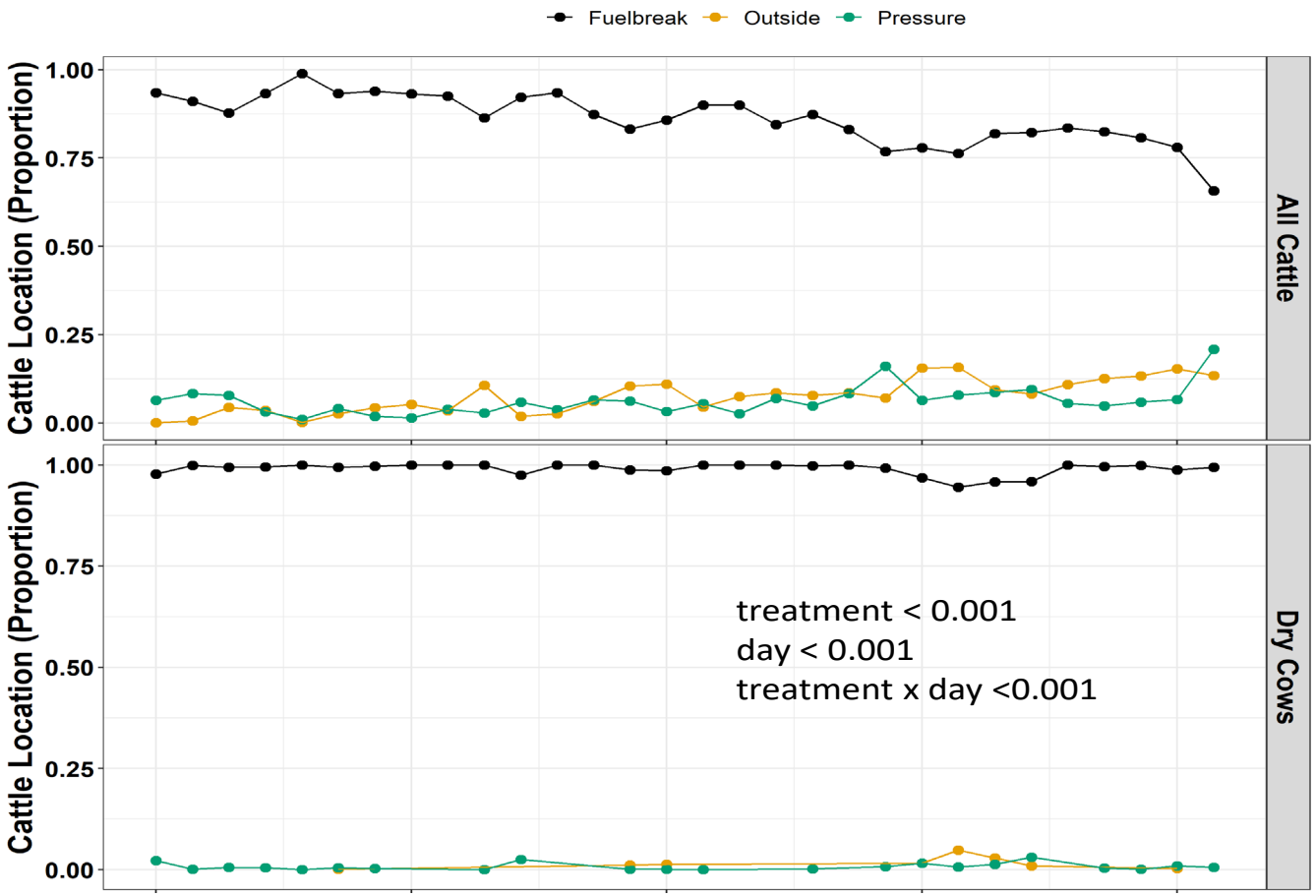
- The proportion of daily locations **within the fuel break-differed ($p < 0.001$) between dry cows and cows with calves.**



Results

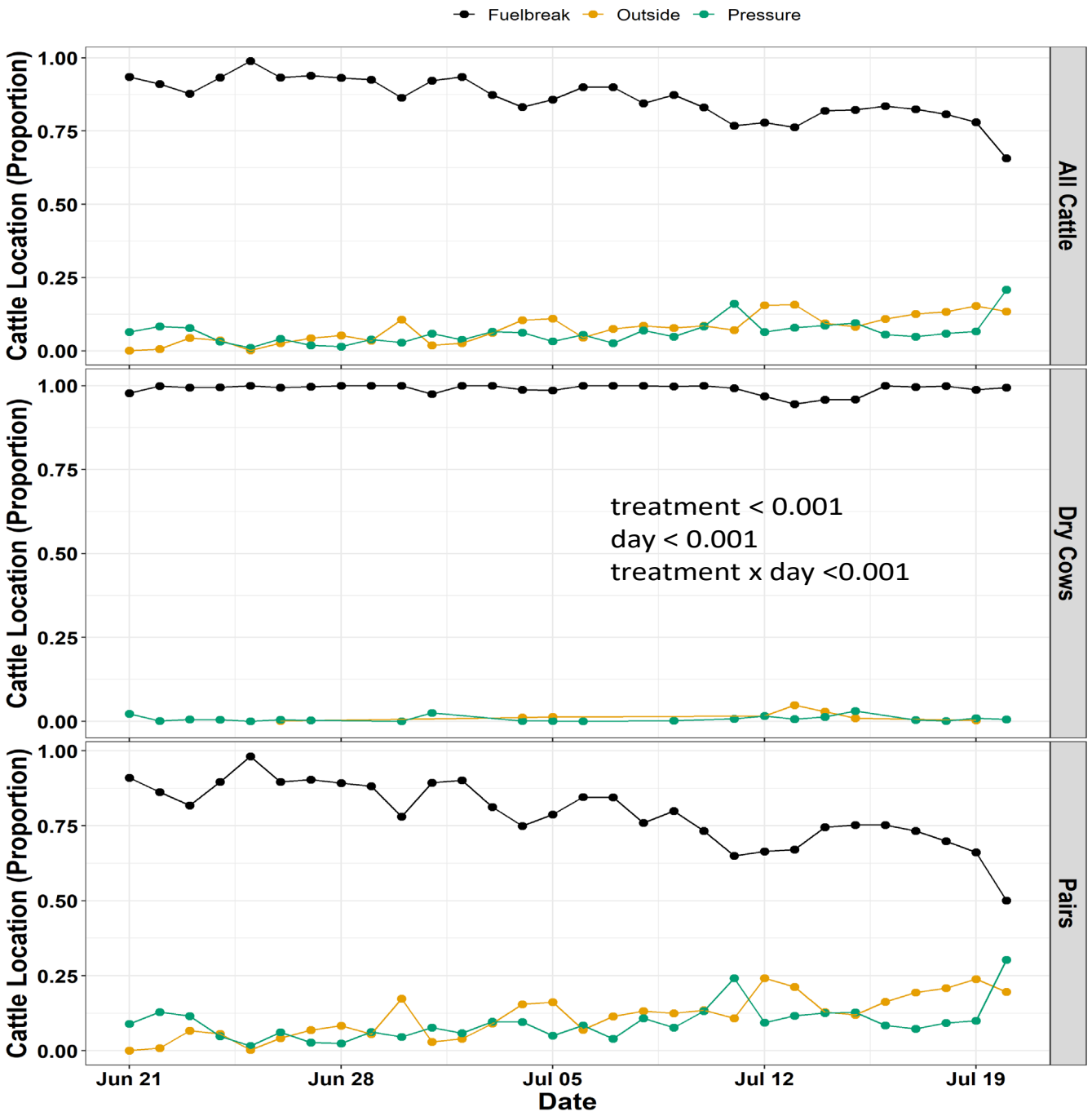
- The proportion of daily locations **within the fuel break-differed (p < 0.001) between dry cows and cows with calves.**

- **Dry cows showed no discernable pattern** in daily locations within the fuel break over time



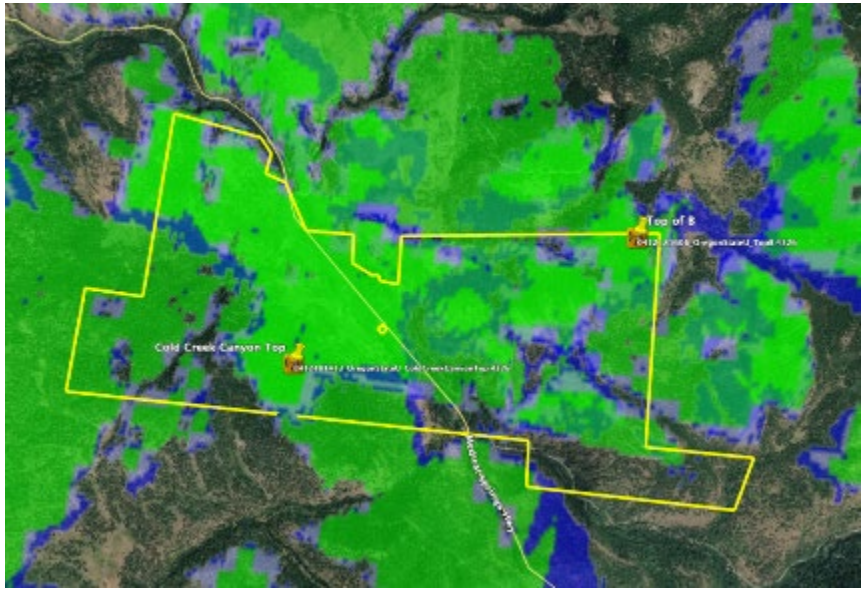
Results

- The proportion of daily locations **within the fuel break-differed (p < 0.001) between dry cows and cows with calves.**
- **Dry cows showed no discernable pattern** in daily locations within the fuel break over time
- Whereas values for **cows with calves decreased over the duration of the trial** and had nearly equal odds of being located within or not within the fuel break by the last day of the trial.



Ongoing Research

1. *Use of VF to reduce riparian area disturbance*



- Goals is to reduce grazing in riparian areas using VF to exclude cattle from sensitive areas.

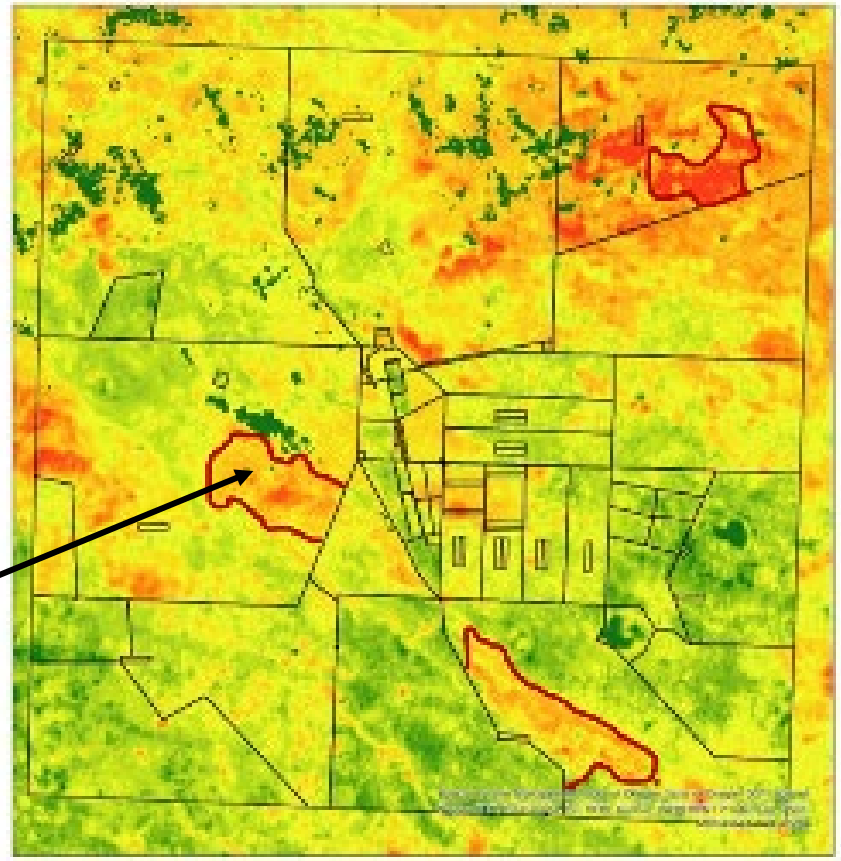
Ongoing Research

1. ***Coordination with remote sensing technology to identify target areas to strategically reduce fuel loads***

Rangeland Analysis Platform

- ***RAP:*** relative probability of large (> 1,000 acres) rangeland fire. Probabilities are calculated using RAP biomass, RAP cover, and various climate/drought indices.

- Goal to reduce fine fuels load with grazing on identified areas.



Northern Great Basin Experimental Range “Butte” in southeast Oregon

Summary

- Cattle **did not develop a negative association** with the VF management zones, in fact, cattle quickly learn to avoid the VF management zones upon stimuli, which decreased overtime.
- The use of **VF does not seem to interfere** with cattle behavior
- Cattle learn to rely **primarily on auditory cues**, and electric cues does not seem to disturb cattle physiology
- The use of VF was **effective at preventing cows from entering or exiting the VF management zones**. Not collared calves might impose a challenge.

Not an iron gate but allows management to individual animal level.

Questions?

THANK YOU!

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Eastern Oregon Agricultural Research Center
Burns, OR.

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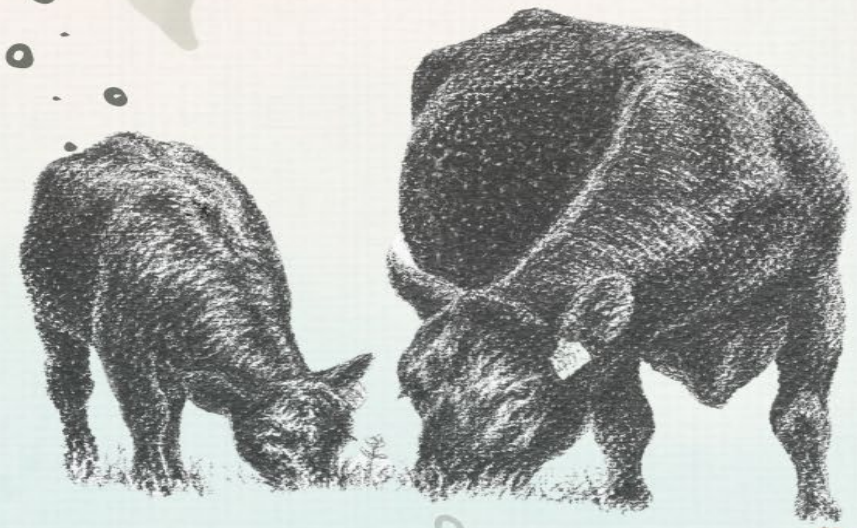
RanchHER 2022

From women for women. All welcome!



YOU ARE INVITED!

November 29, 30, and December 1st, 2022 at 4:00 pm PT

ONLINE & FREE

November 29

***Gaby Maier**, PhD - University of California*
Assistant Professor in Cooperative Extension for Beef Cattle Herd Health & Production
A Pinch of Prevention is Worth a Pound of Cure - How to Prevent the Most Commonly Treated Diseases in your Herd

***Amy Skibiel**, PhD - University of Idaho*
Assistant Professor, Lactation Physiology
Particulates in Wildfire Smoke and the Impacts on Dairy Cow and Calf Health and Performance

November 30

***Jade Cooper**, PhD - Texas A&M*
Assistant Professor and Extension Meat Specialist
From Farm to Fork and All Things in-between: Direct Marketing of Beef, the Not So Direct Path

***Julia Livingston** - J3L Meat LLC.*
Getting Started: My Experience with Direct Market Beef

December 1st

***Alice Brandao**, PhD - Texas A&M*
Instructional Assistant Professor
Supplementation of Essential Fatty Acids in Cow-Calf Operations

***Kelsey Harvey**, PhD - Mississippi State University*
Assistant Professor
Mineral Nutrition During Gestation: Impacts on Cattle Productivity

Oregon State University

FREE REGISTRATION AT:

https://oregonstate.zoom.us/webinar/register/WN_A6DbFLGzTTGs1tgwwbu4vw

This is an Oregon State University event organized by Juliana Ranches.
Questions? Please contact Juliana at juliana.ranches@oregonstate.edu or (541) 573-4083 or (941)780-7932