IMPACT OF VIRTUAL FENCE TECHNOLOGY ON STEER BEHAVIOR, PERFORMANCE, AND ENERGETIC EXPENDITURE

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KNOWLEDGE GAP

- Lack of knowledge
  - Behavior
  - Animal performance

- There is a need to quantify behavior and performance with VF
  - ADG and behavior (grazing, resting, and walking time)
  - Animal energetics

STUDY SITE

- SDSU Cottonwood Field Station
  - Northern Great Plains mixed grass prairie
  - Topography: elevation ranges from 710 to 784 m; 5.7% slope
  - Annual Precipitation:
    - 2021: 278 mm
    - 2022: 267 mm

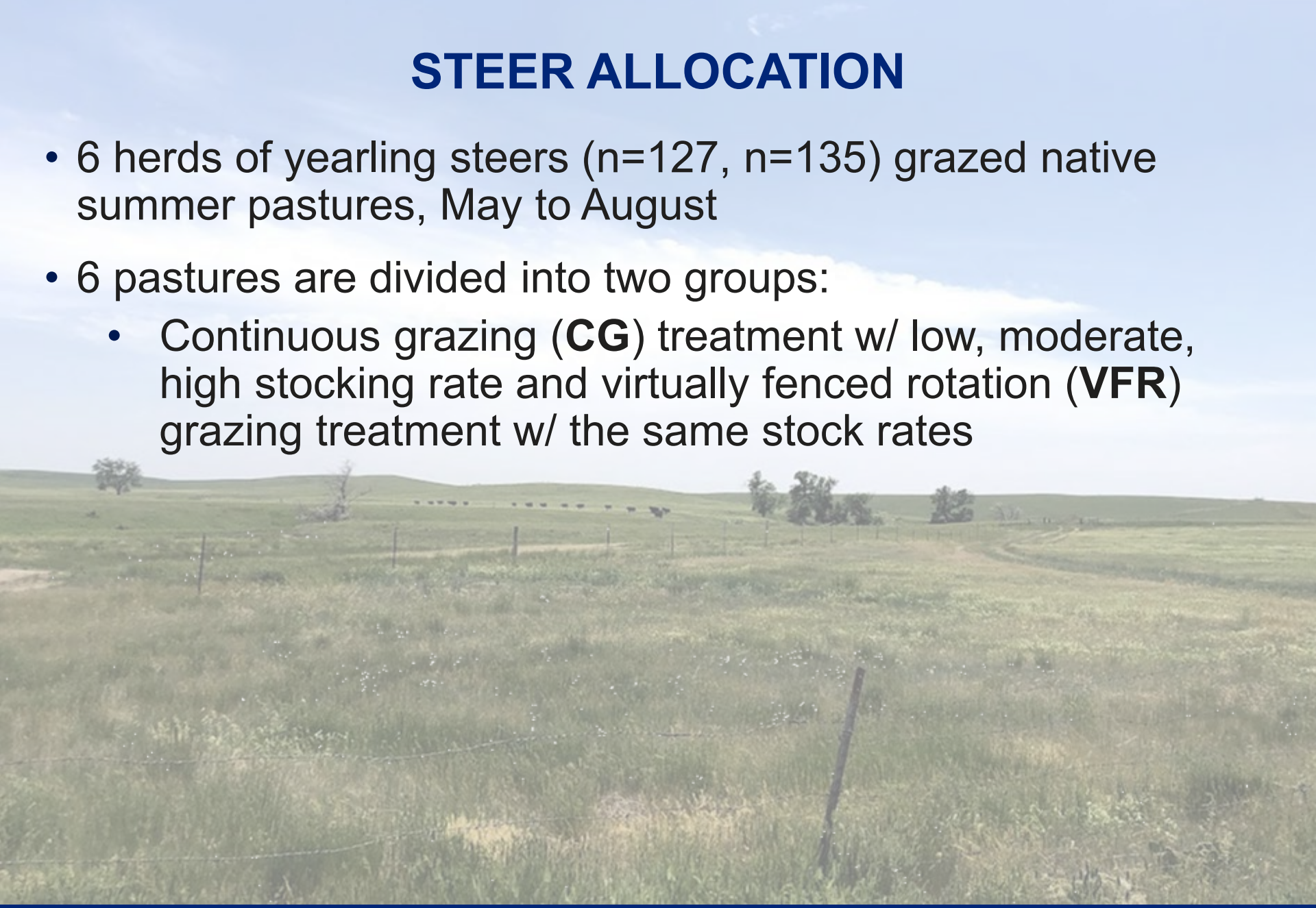
HYPOTHESIS

- We hypothesized that continuous grazing (CG) steers will have greater daily gains and have lower daily distance traveled (DDT)

  - Our objectives were to:
    - Calculate animals DDT
    - Quantify total time spent walking, resting, and grazing
    - Determine individual animal performance between stocking rate and treatment

STEER ALLOCATION

- 6 herds of yearling steers (n=127, n=135) grazed native summer pastures, May to August
- 6 pastures are divided into two groups:
  - Continuous grazing (**CG**) treatment w/ low, moderate, high stocking rate and virtually fenced rotation (**VFR**) grazing treatment w/ the same stock rates

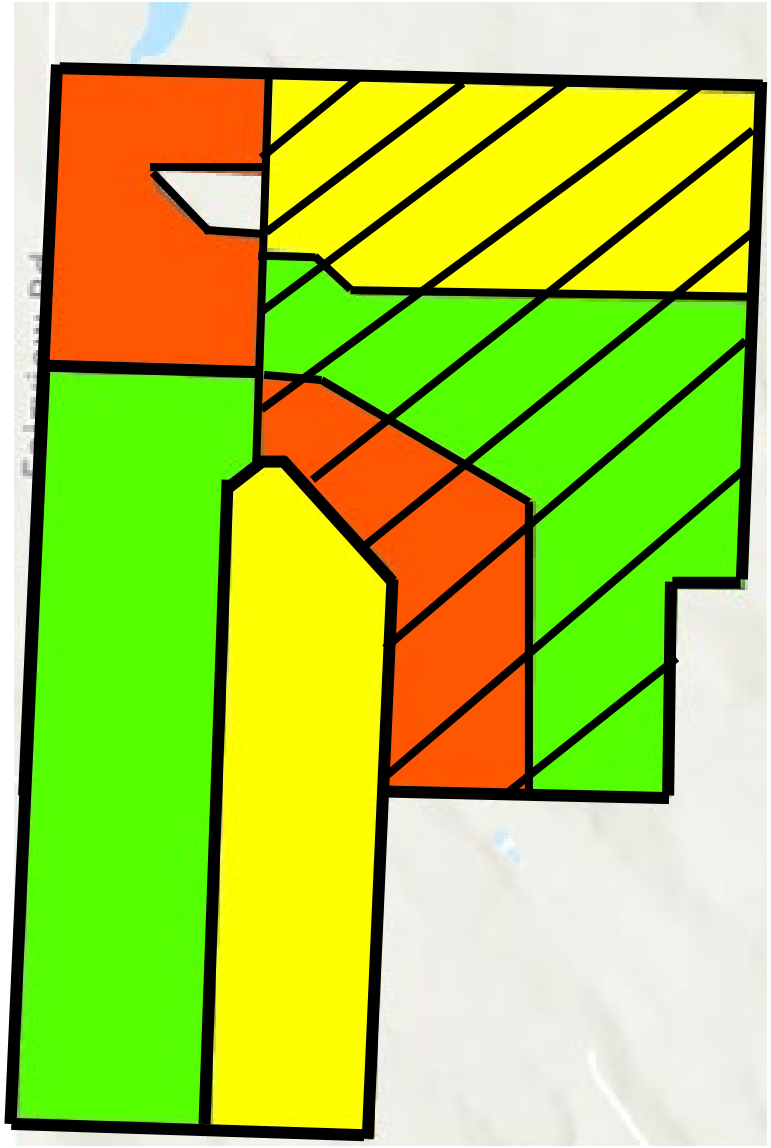


COLLARING OF ANIMALS

- Vence™ collars were placed on all steers
  - CG collars not actively managed, but recorded GPS data
  - Animals within VFR were rotated 3-4 times during summer

TRIAL PASTURES

Pasture	AUM	Treatment	Color
1	0.72	Continuous	Orange
2	0.40	Virtual Fence	Yellow (Striped)
3	0.32	Virtual Fence	Green (Striped)
4	0.72	Virtual Fence	Orange (Striped)
5	0.40	Continuous	Yellow
6	0.32	Continuous	Green



ANALYSIS

- Data analysis:
  - Vence™ data was downloaded from the VF software through an application programming interface (API) in Python
  - Data was sorted and cleaned in R
  - Analyzed as a linear mixed effects model ($p < 0.05$)

Variables

Fixed: treatment, stocking rate, and year

Random: collars (individual animals)

Response: behavior and ADG

CONTAINMENT RATE AND COLLAR RETENTION

CONTAINMENT RATE

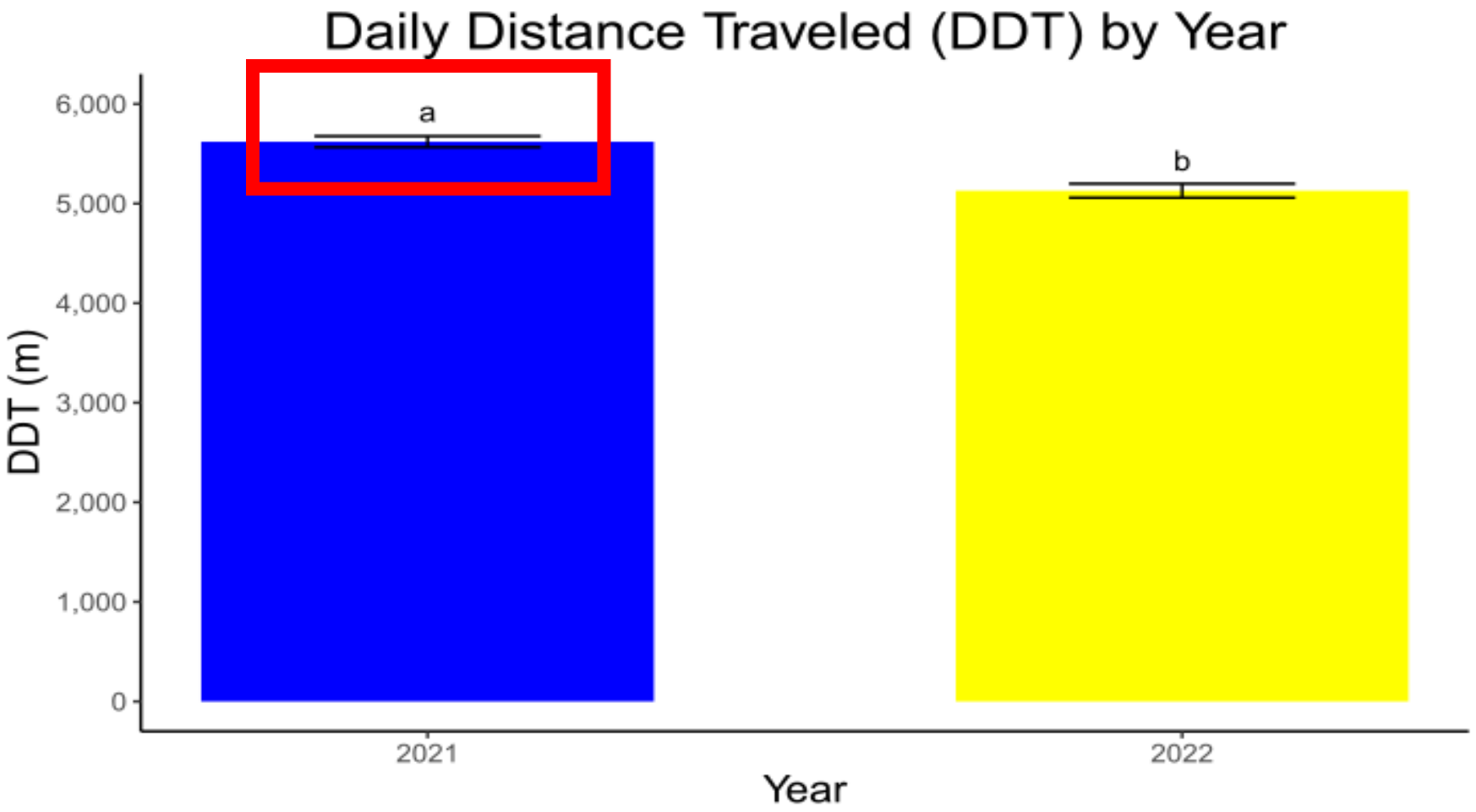
Stocking Rate	2021	2022
Light	69	72
Moderate	78	73
Heavy	70	54

RETENTION RATE

Year	% Retained Collars
2021	77
2022	44

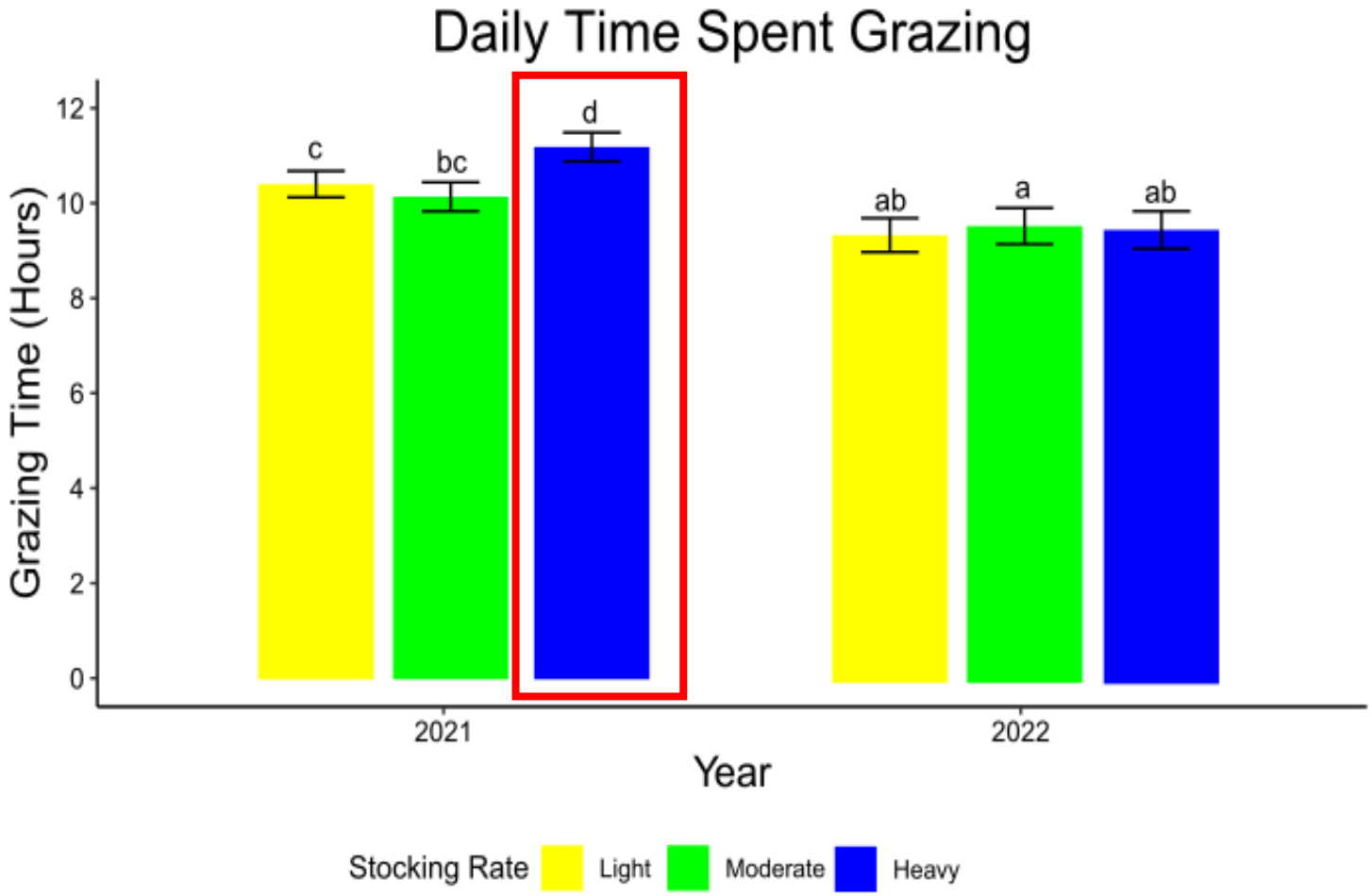
Observed differences can likely be attributed to collar design

DAILY DISTANCE TRAVELED



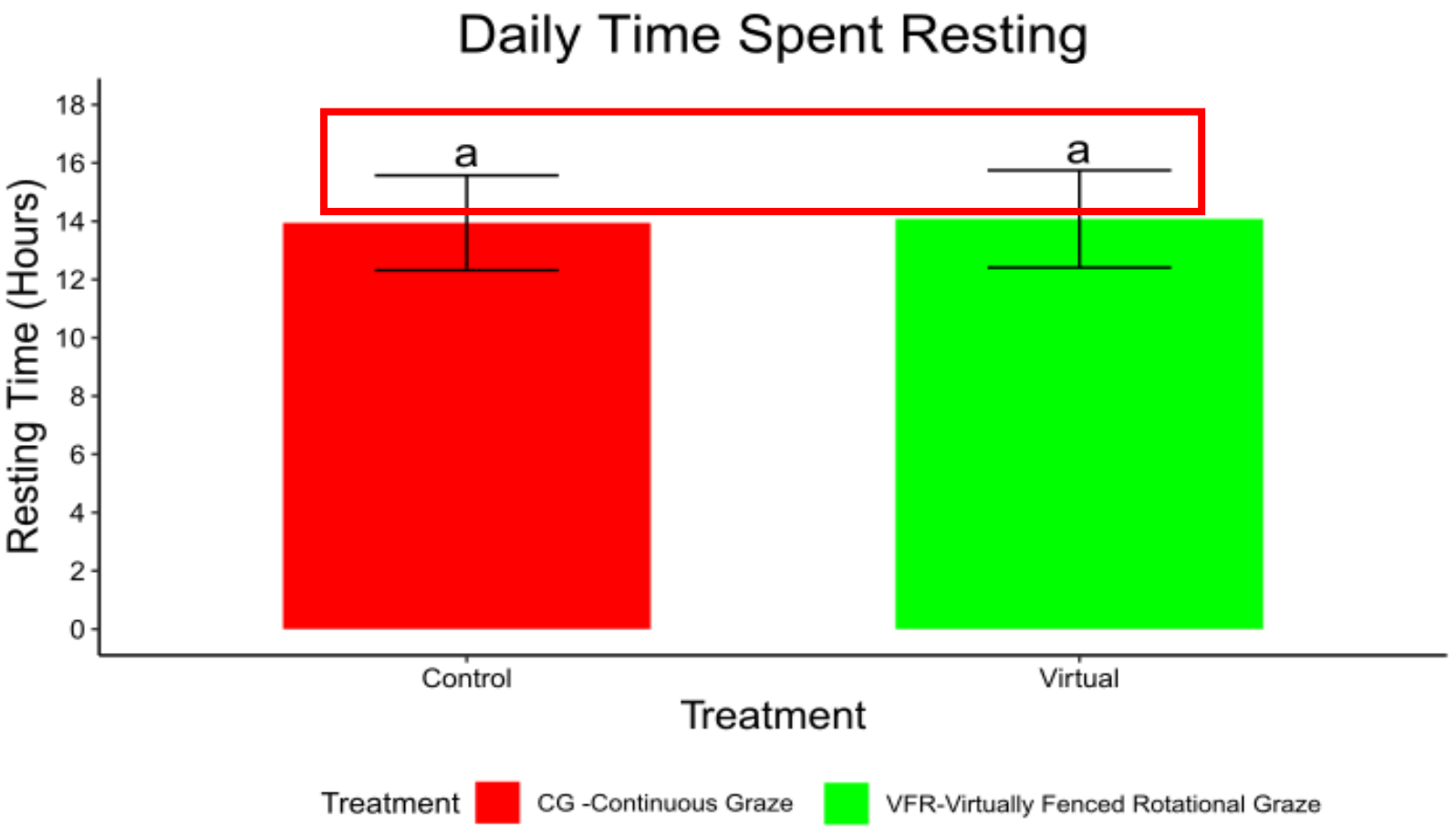
DDT was significantly impacted by year ($p < 0.05$)

GRAZING BEHAVIOR



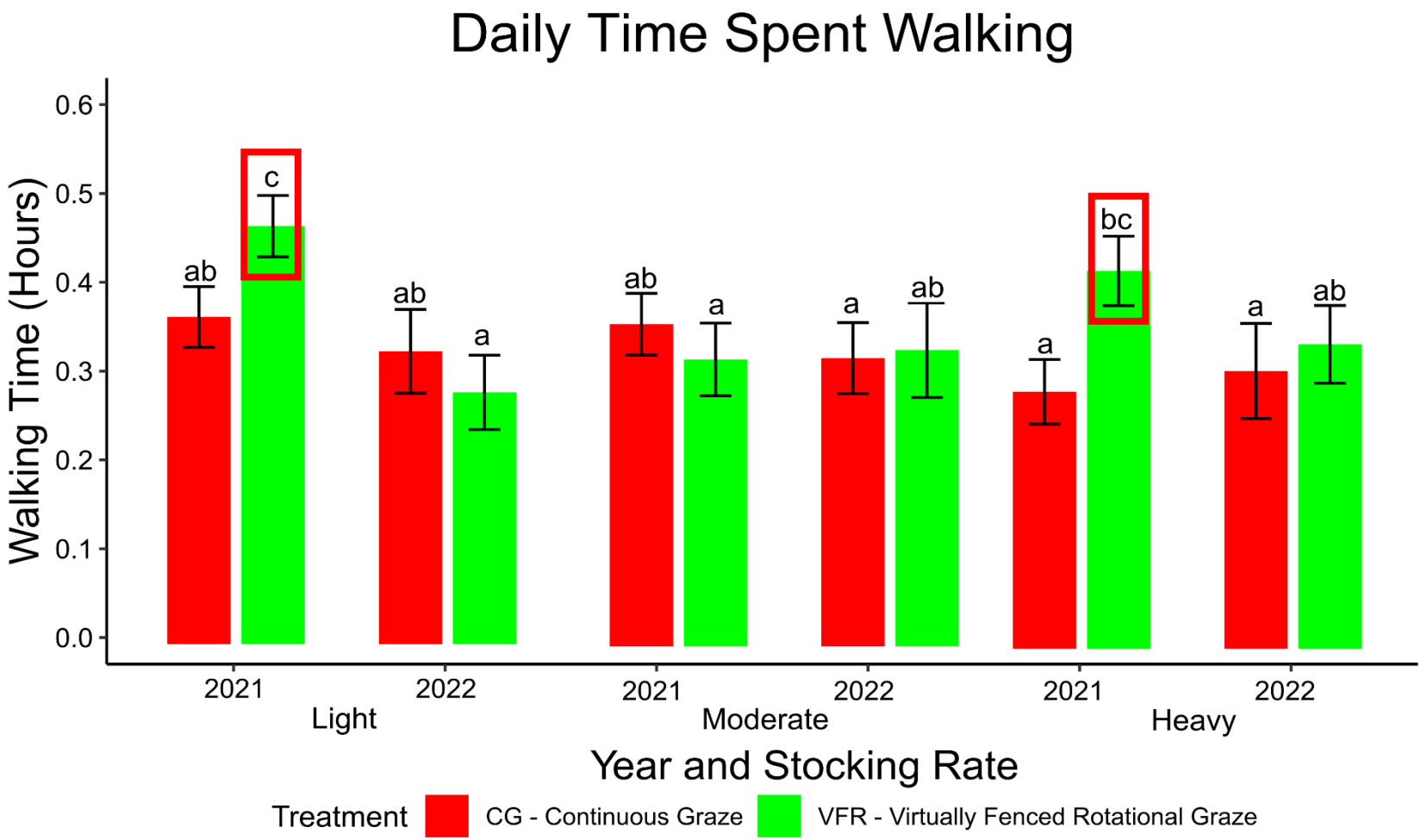
Grazing time was significantly impacted by stocking rate depending on year ($p < 0.01$)

RESTING TIME



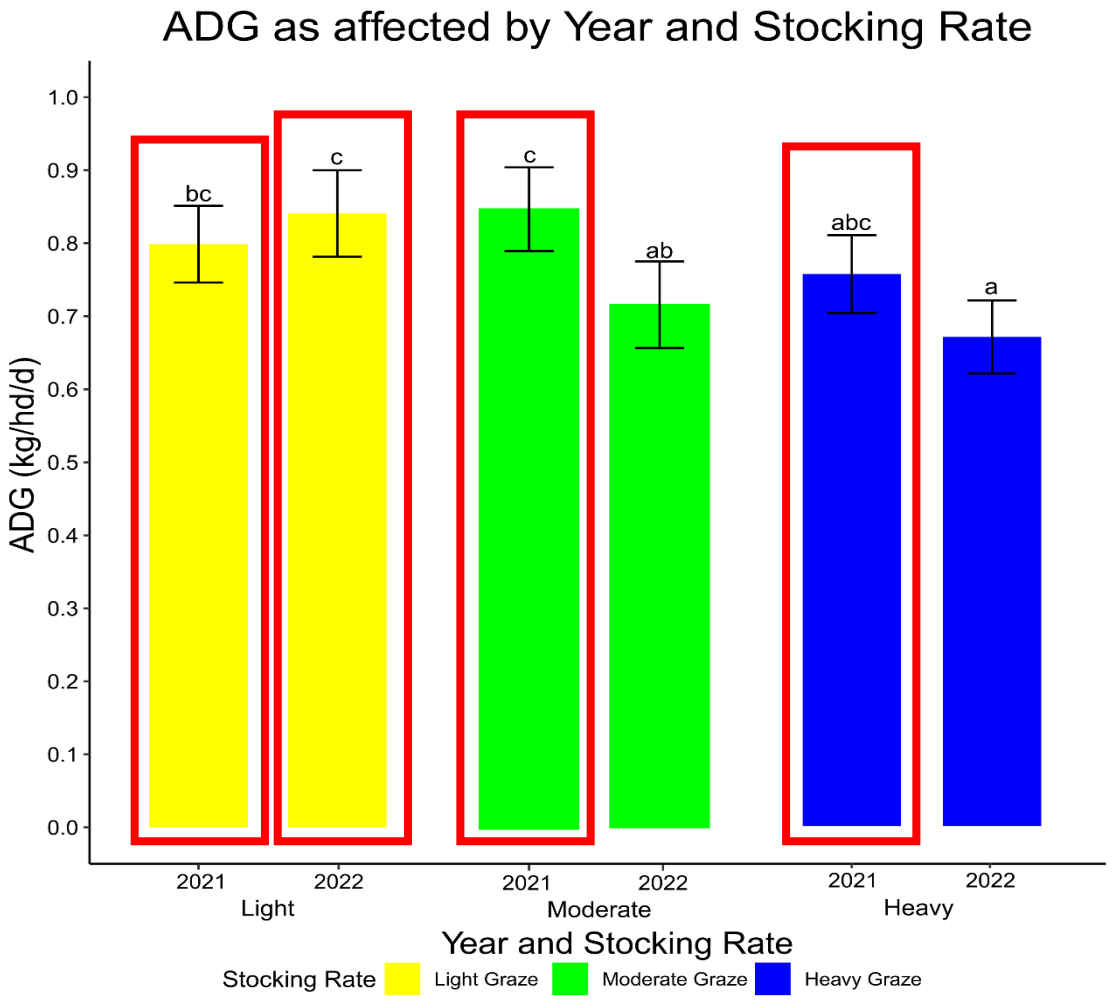
Resting time was not significantly impacted by treatment, stocking rate, or year ($p < 0.05$)

WALKING BEHAVIOR



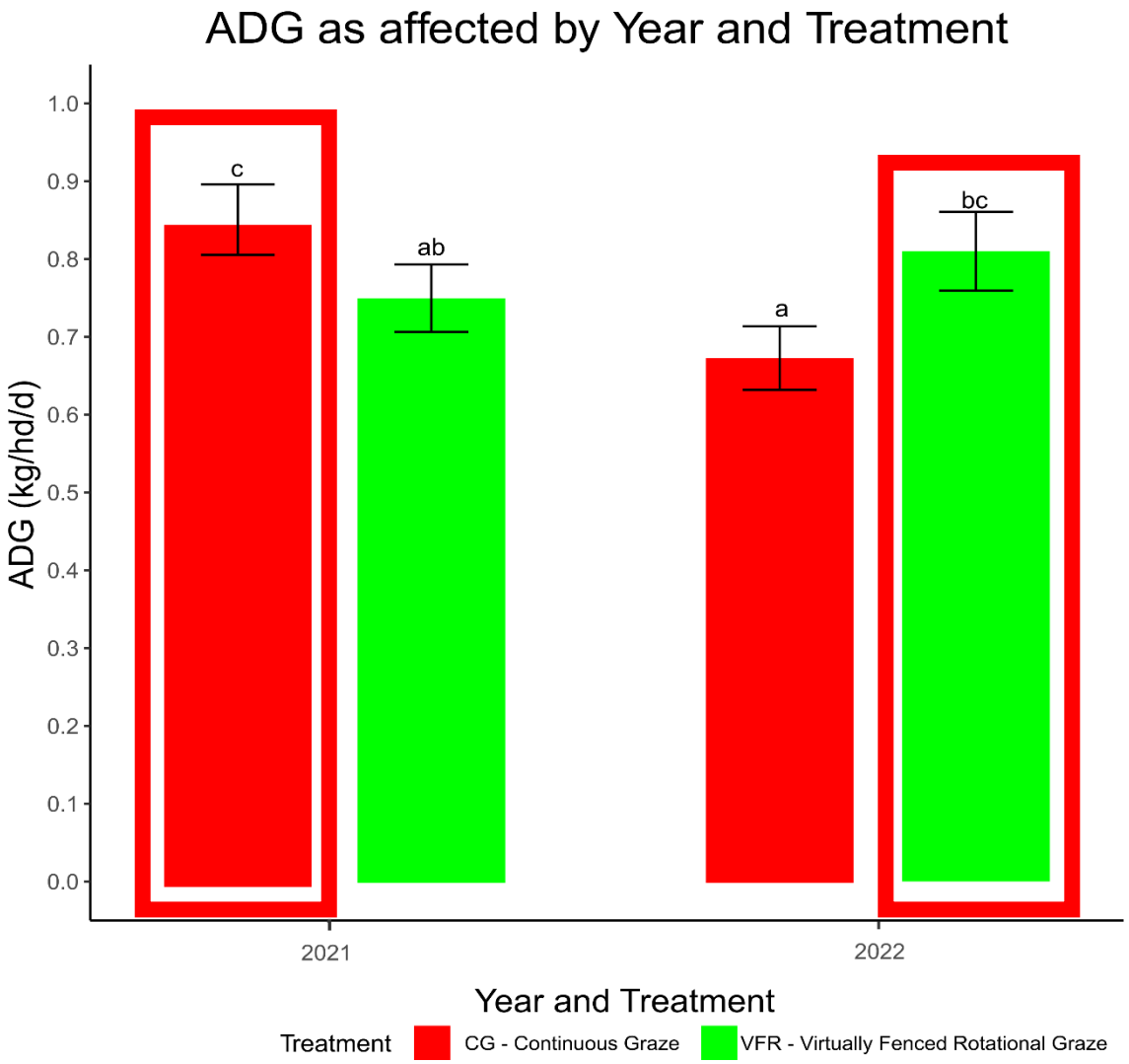
Walking behavior was significantly impacted by stocking rate and treatment, depending on year ($p < 0.01$)

WEIGHT DATA



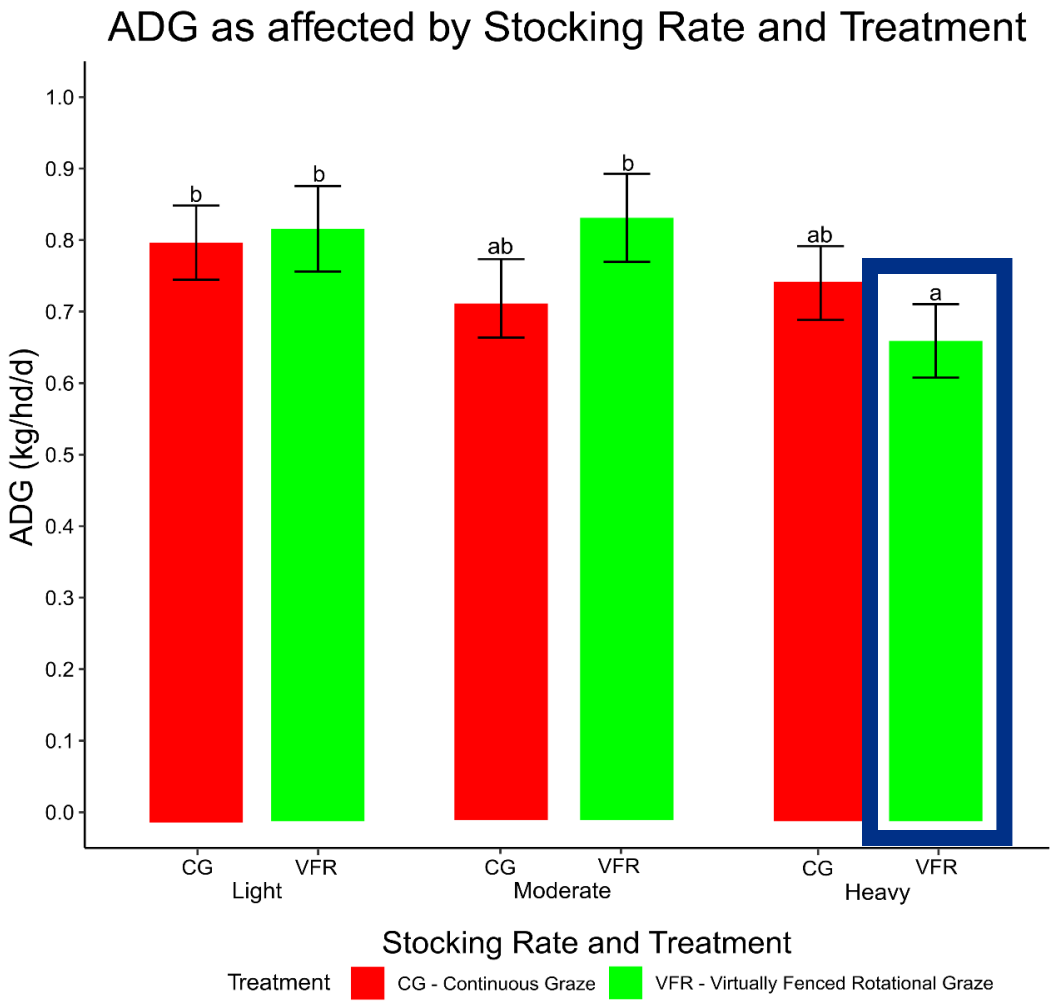
ADG was significantly impacted by stocking rate depending on the year ($p < 0.01$)

WEIGHT DATA



ADG was significantly impacted by treatment depending on the year ($p < 0.01$)

WEIGHT DATA



ADG was significantly impacted by stocking rate, depending on treatment (P = 0.03)

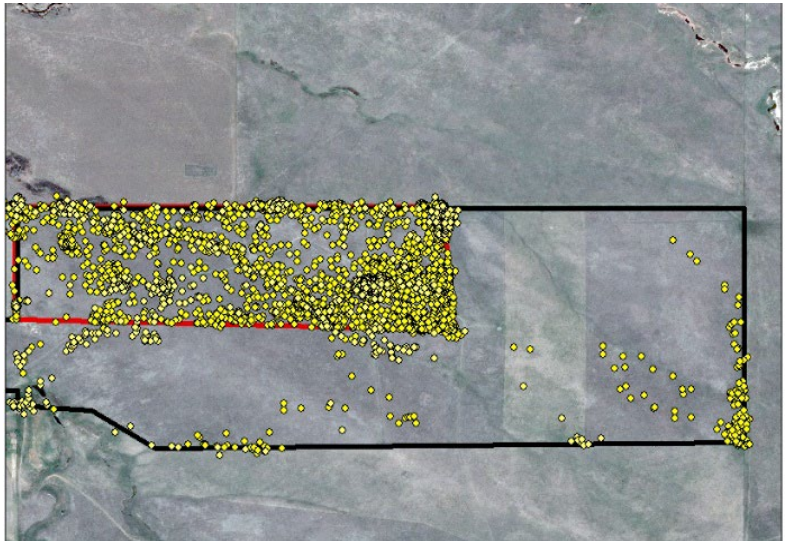
KNOWLEDGE GAP

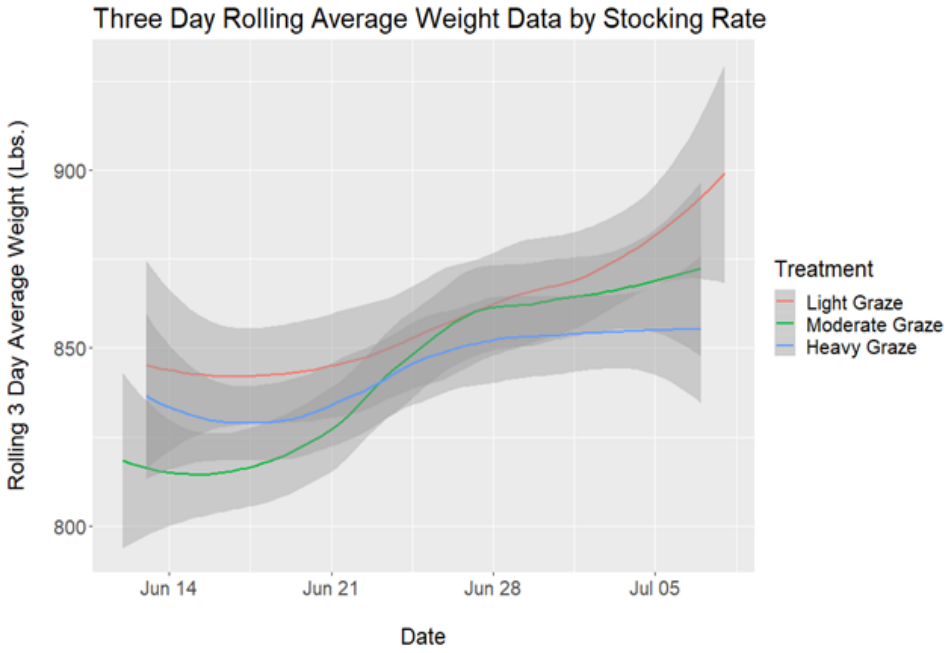
- Short comings of previous rangeland energetic equations for activity
  - Osuji 1974 → variety of behaviors and their EE
  - Fox 1988 → empirically derived equation, increase of 20%
  - Tedeschi and Fox 2020 → Confined systems

- Refining previous rangeland energetic equations by capturing individual animals
  - Pasture based weighing systems
  - GPS collars

PRECISION DRIVEN DATA

- Fine scale data can help quantify energetic costs for rangeland cattle

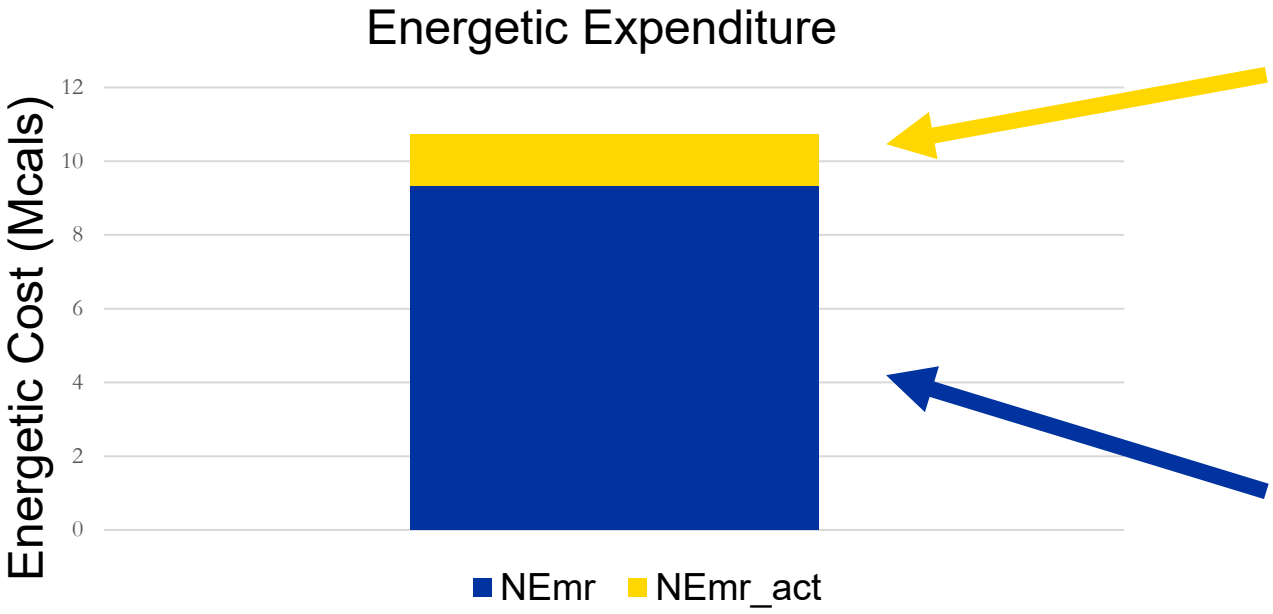




- GPS and precision weighing systems
  - Evaluate energetic differences across landscapes

PRECISION MODEL DEVELOPMENT

$$NEmr\_act = \frac{(0.1 * \text{resting time} + 0.062 * 6 + 0.621 * \text{km flat travel} + 6.69 * \text{km ascending travel}) * FBW}{100}$$



NEmr_act:
Walking
Running
Grazing

NEmr:
Ruminating
Drinking water
Breathing

- Estimating NEmr_act
  Tedeschi and Fox (2020), Tedeschi (2023)

ESTIMATING NEmr_ACT

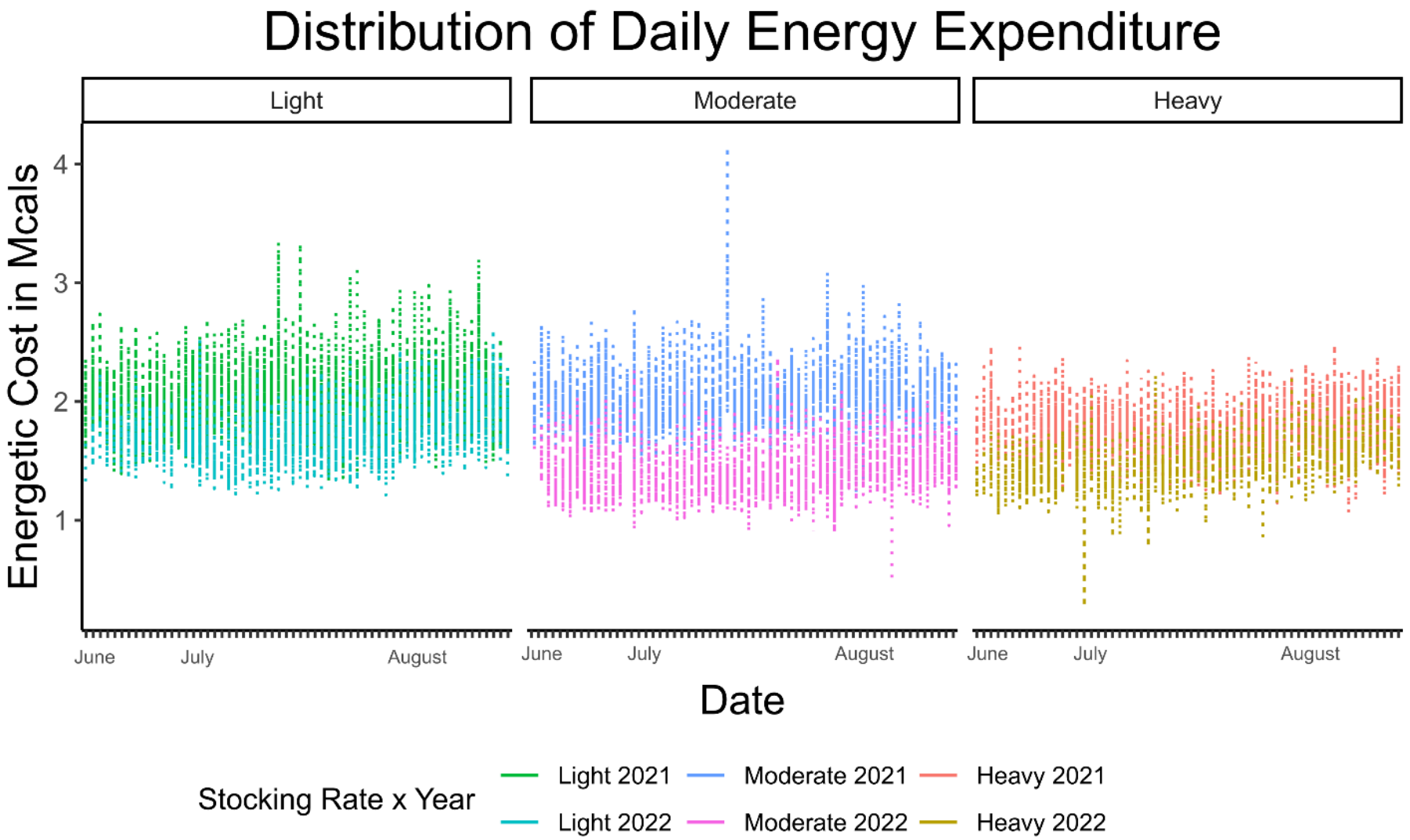
Precision NEmr_act model

NEMR ACTIVITY COSTS PER DAY

Year	Treatment	Stocking Rate	Mcals/day	SE	Group
2021	VFR	Light	1.90	0.04	def
		Moderate	1.96	0.05	ef
		Heavy	1.83	0.05	cde
	CG	Light	2.05	0.04	f
		Moderate	2.00	0.04	ef
		Heavy	1.72	0.04	cd
	AVG		1.92		
2022	VFR	Light	1.79	0.05	cde
		Moderate	1.61	0.07	bc
		Heavy	1.46	0.05	ab
	CG	Light	1.64	0.06	bc
		Moderate	1.28	0.05	a
		Heavy	1.43	0.06	ab
	AVG		1.53		

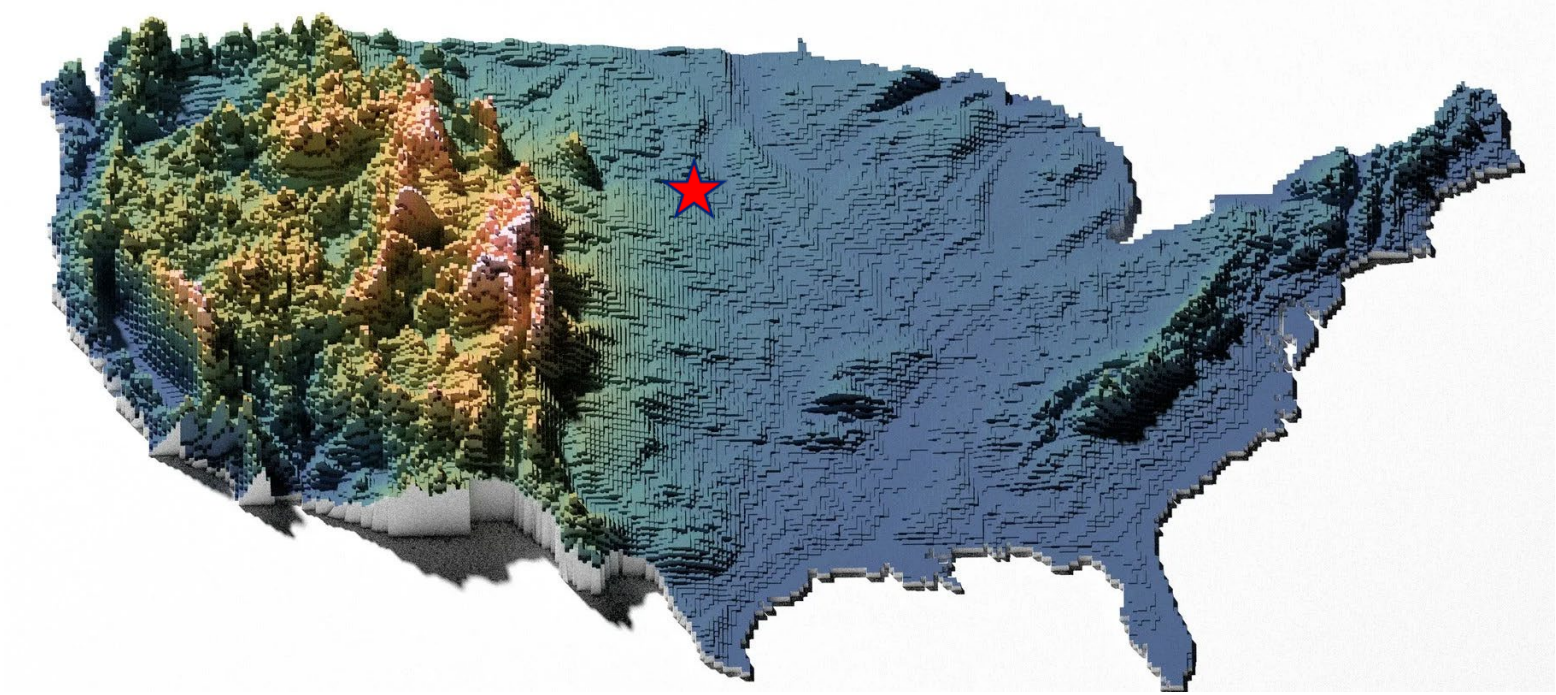
Stocking rate by treatment interaction depending on year ($p < 0.01$)

NEMR MCALS


Distribution of Daily Energy Expenditure
Light
Moderate
Heavy
Energetic Cost in Mcals
4
3
2
1
June
July
August
Date
Stocking Rate x Year
Light 2021
Moderate 2021
Heavy 2021
Light 2022
Moderate 2022
Heavy 2022

IMPLICATIONS

- First step towards leveraging precision data in impactful ways to improve rangeland cattle production
  - As precision technology becomes scalable results will compound
  - Cattle energetics in midwestern rangelands vs intermountain west



DIFFERENCES WE SAW

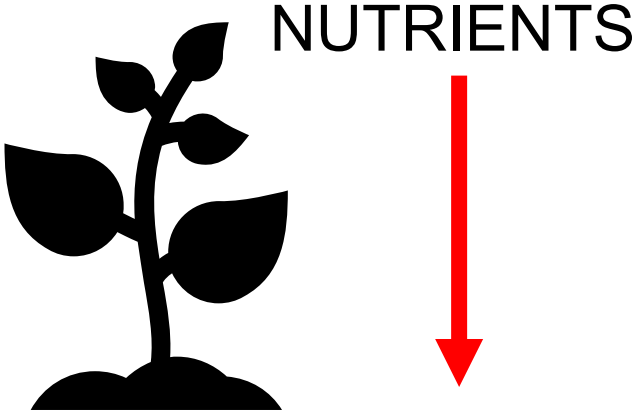
- What we found:
  - DDT varied between years but not among treatment or stocking rate

- Possible reasons
  - Pasture layout/design
  - Technology implemented

VS.

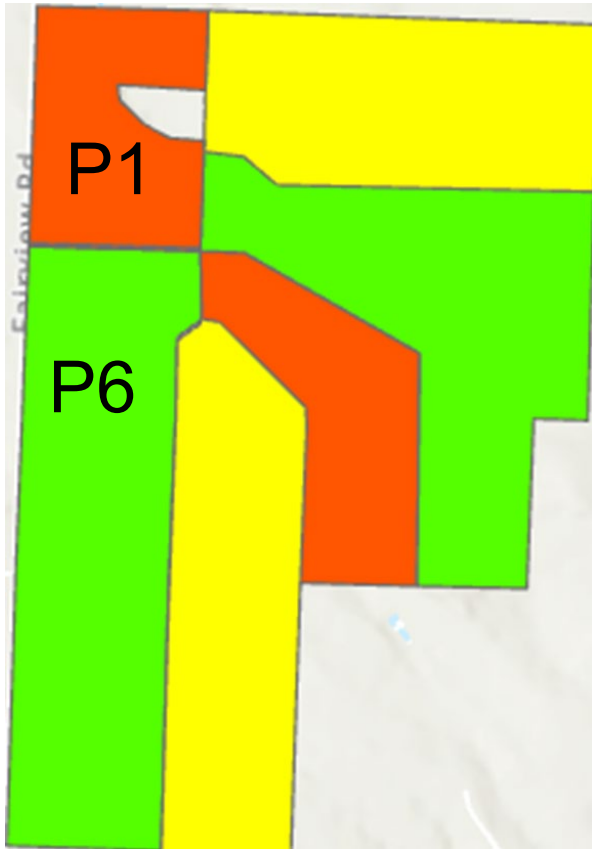
DIFFERENCES WE SAW

- What we found:
  - Heavy stocking rate steers in 2021 spent the most time grazing
- Stocking rate can impact grazing efficiency
  - Literature suggests grazing efficiency increases in high stocking rates and decreases in light stocking rates (Smart et al., 2010)
- Possible reasons
  - Reduced biomass availability (Drought)
  - Senescence
  - C3 vs C4 grasses
    - C4 grass quality declines in drought



DIFFERENCES WE SAW

- What we found:
  - ADG varied by treatment and stocking rate depending on year
- Lack of consensus in literature
- Possible reasons
  - Reduction in forage quality
  - Forage differences in pastures
    - P1 → Buffalograss, Blue Gramma, etc.
    - P6 → Western Wheatgrass, GNG, etc.



CURRENT KNOWLEDGE

- Stress Response with VF:
  - No difference in stress response or behavior between virtual fence and electric tape
    - 4-week trial (Campbell et al., 2019)
  - No difference was observed in cortisol, lactate, or nonesterified fatty acids (NEFA) concentrations based on fence type ($p > 0.14$)
    - 56-day trial (Jeffus et al., 2021)

CONCLUSION

- Virtual fencing does not negatively impact animal behavior and performance
  - Warranting it as a possible solution to implement in grazing regimes
    - Yearling DDT had a year effect and no treatment effect
    - Behavior did not biologically impact steers by treatment
    - ADG was not significantly impacted by treatment
- Virtual fencing has a promising future however…..
  - Collar retention needs to be increased
  - Design/manufacturing improvements
  - App creation for software


QUESTIONS?

Exploring the Boundaries of Virtual Fence

Access factsheets, videos, webinars & more resources

rangelandsgateway.org/vf

Webinar 1 - Recording, slides, handouts available online

Virtual Fence 101 & Vendor Comparison

Webinar 3 - January 23, 2025 - Registration is Open

Virtual Fence Economics

The University of Arizona

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CITATIONS

Boyd, C., O'Connor, R., Ranches, J., Bohnert, D., Bates, J., Johnson, D., Davies, K., Parker, T., Doherty, K. Virtual Fencing Effectively Excludes Cattle from Burned Sagebrush Steppe. Rangeland Ecology & Management, Volume 81, 2022, Pages 55-62. ISSN 1550-7424. https://doi.org/10.1016/j.rama.2022.01.001

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