Using GPS Collars to Measure Rangeland Utilization and Resilience of Livestock

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Gordon Research Seminar on Quantitative Genetics and Genomics
Saturday, February 11th, 2023

Challenges Facing Extensively Managed Operations

- Scale
- Terrain
- Hotter, Drier Climate
- Resource Distribution
- Disease
- Predation

Resilience, Welfare & Productivity

Climatic Variability Necessitates Hardy Individuals

Resilience vs Robustness

Hedonic vs Eudaimonic Welfare

GPS as a Precision Livestock Farming Tool

- $60 per unit
- Runtime of 15.4 ± 7.30 days
- Recording attempt every 10 min

Collared Sheep Summary

- 112 Collared sheep:
  - Merino
    - Ewes: 10; Lambs: 10; Pairs: 8
  - Merino X Rambouillet Composite
    - Ewes: 35; Lambs: 40; Pairs: 35
  - Unknown Merino/Rambouillet
    - Ewes: 10; Lambs: 7; Pairs: 7
- Average ewe age: 5 ± 2 years
- Average lamb age: 101 ± 1 days

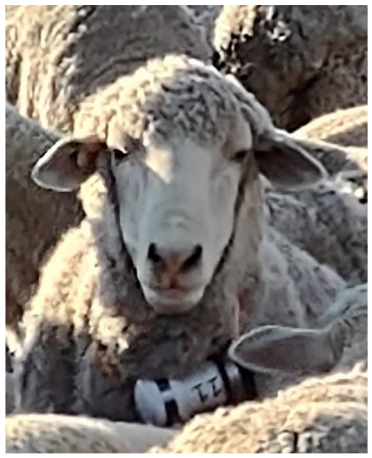
GPS Metrics & Derived Phenotypes

Raw Data:

- Longitude, Latitude
- Date
- Time

Processed Data:

- Distance
- Altitude
- Slope

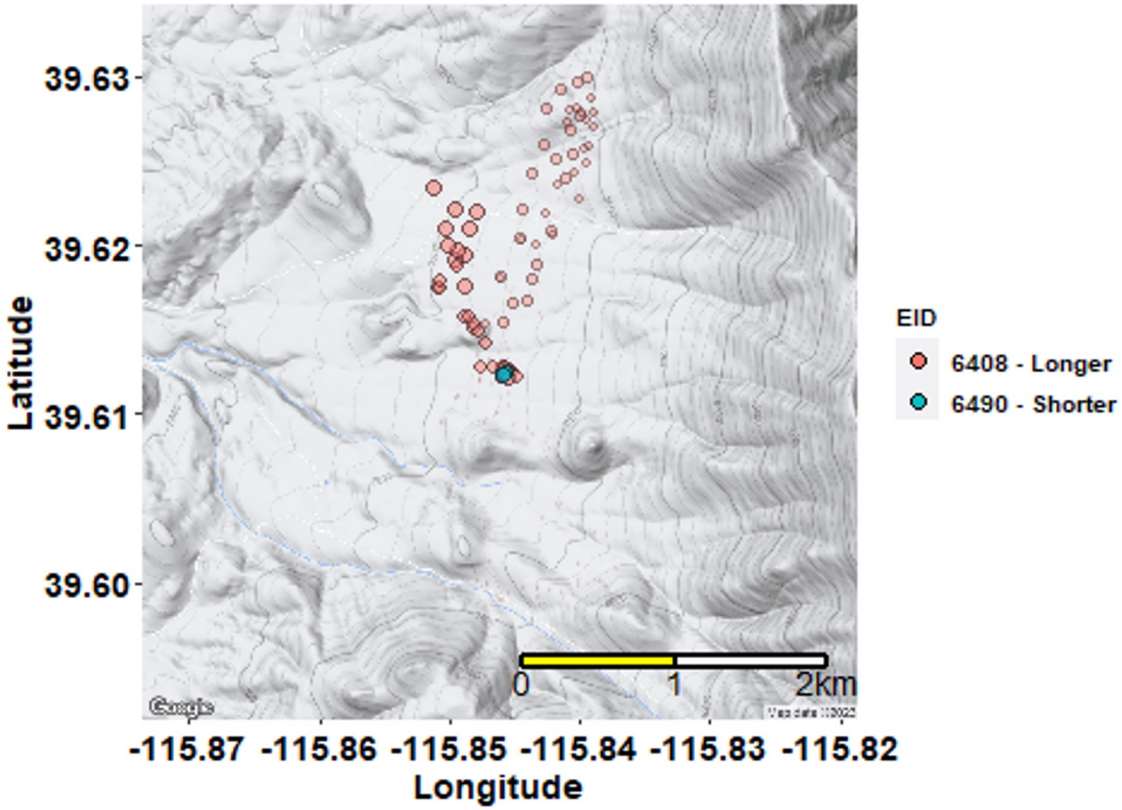


Land Usage Phenotypes:

- Distance traveled
  - Speed
- Hillside usage
- Water usage
- Ewe-lamb proximity
  - Spatial social networks

Distance Traveled

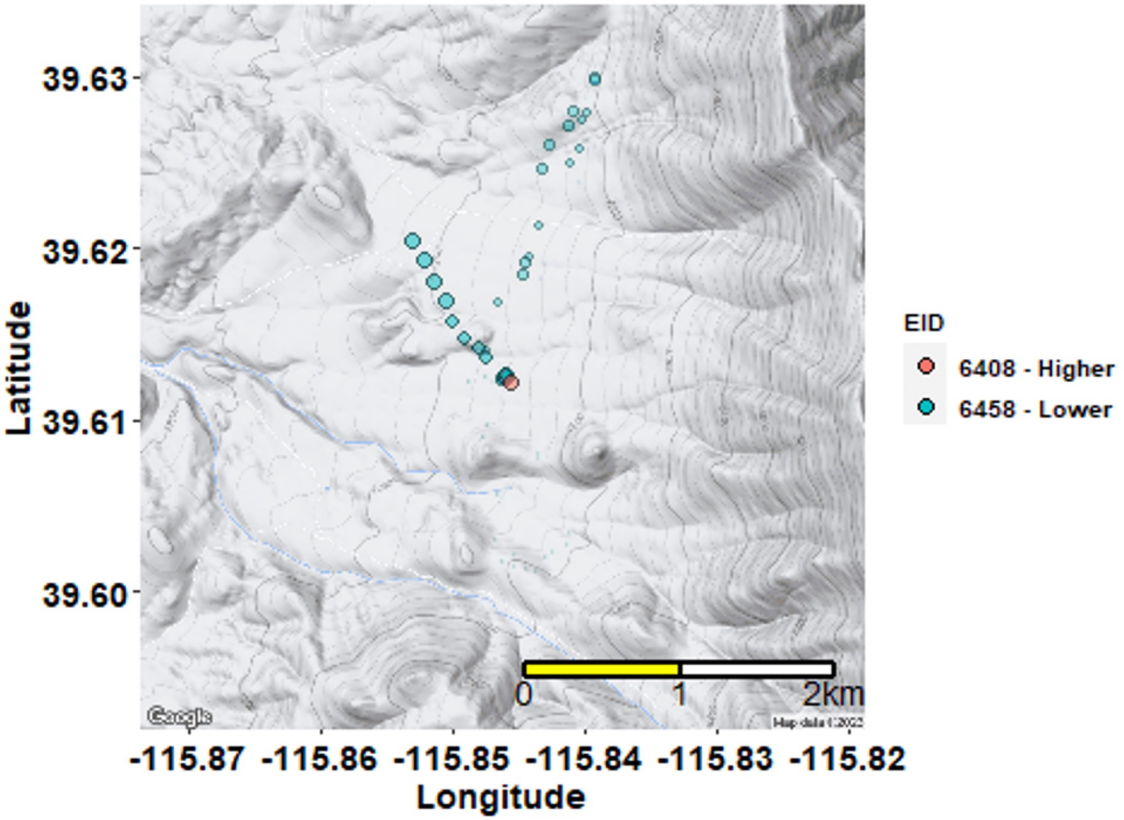
- Energy Expenditure
- Nutritional Density
- Health (lameness)
- Daily Flock Distance
  - 6277 ± 1741 m/day



Longer = 8388 m/day | Shorter = 6883 m/day

Hillside Usage

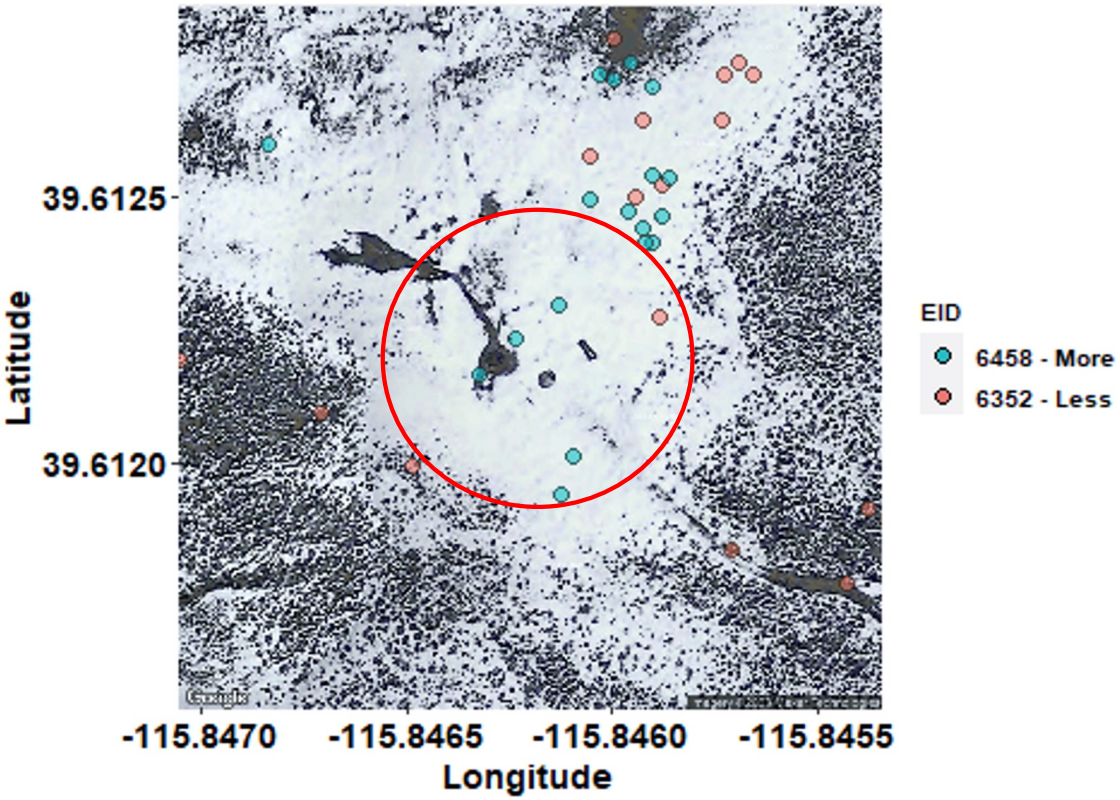
- Climbers
  - Higher nutrition plane
  - Eudaimonic well being
- Bottom Dwellers
  - May indicate heat stress
  - Energetic, physiological stress
- Hill Index Flock Score
  - 0.03 ± 0.27 Z-Score



Higher = 0.389 Z-Score | Lower = -0.274 Z-Score

Water Usage

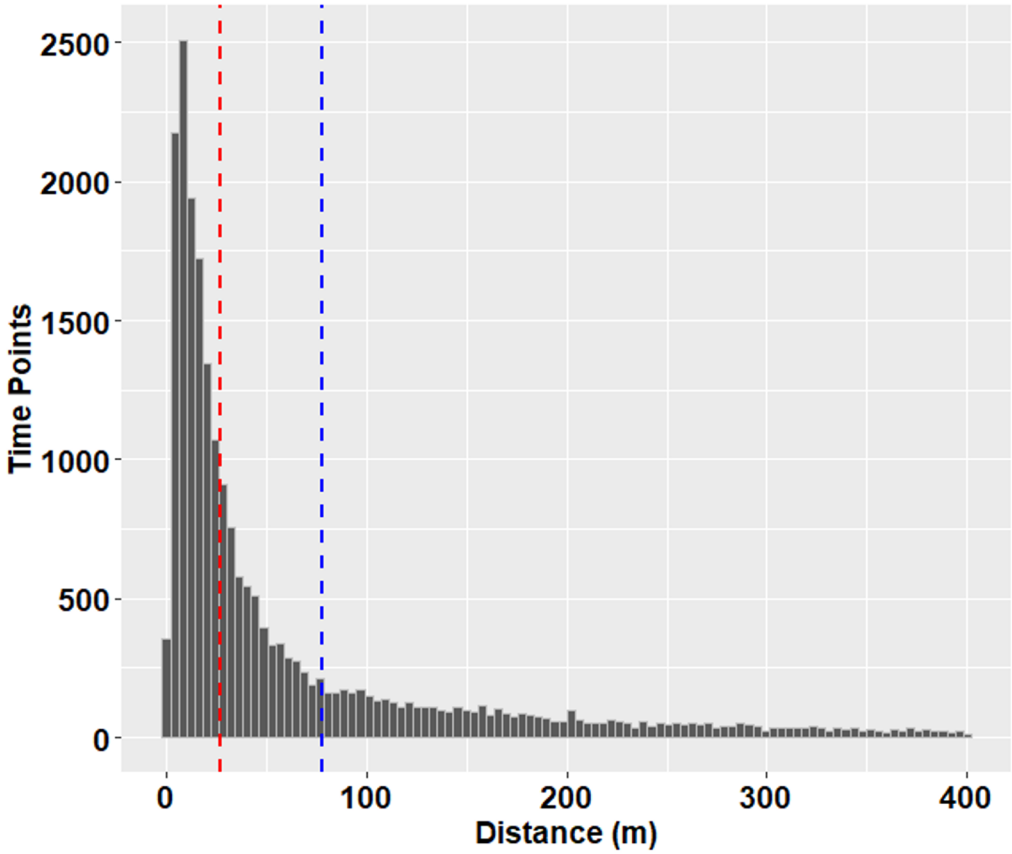
- Indicative of heat stress
- Level of hydration
- Quality of water
- Water availability
- Flock time near water
  - 10.7 ± 5.3%



More = 16.1% | Less = 5.7%

Ewe & Lamb Paired Distance

- Coordinates taken within 5 minutes of each other within ewe-lamb pairs
  - 33 pairs of data within time frame
- 769 ± 670 paired records per ewe
  - 149.70 ± 7.98 s mean lag time
- Mean (blue) = 78.2 m
- Median (red) = 27.1 m

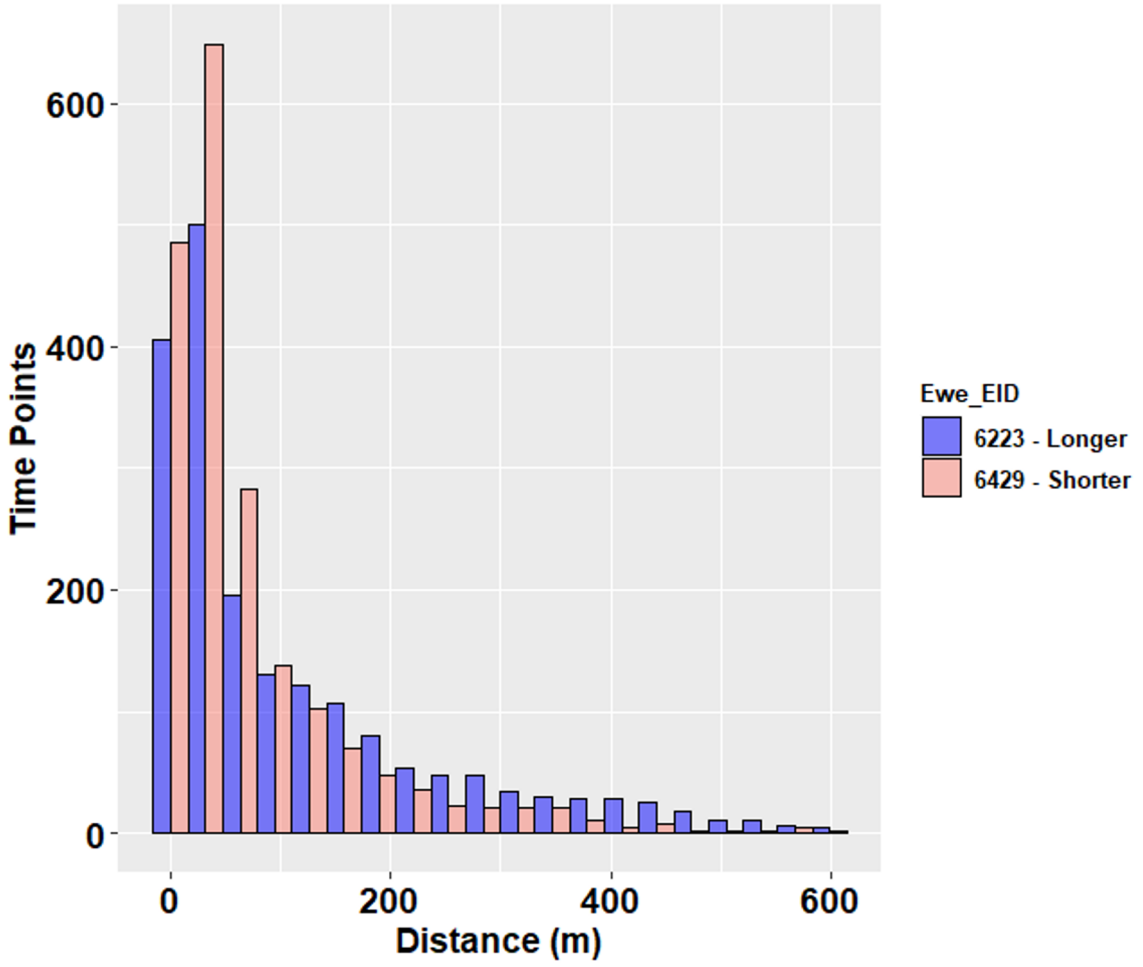


Ewe Lamb Pair Variation

- Mothering ability
- Learned behaviors
- Social connectivity

Longer = 116.1 m

Shorter = 70.8 m



GPS Integration with Longitudinal Data Types

- Daily fluctuations in productivity (body weight) fundamentally describe resilience
  - Measured via walkover weigh (WoW) station
- Overlay climate data

Night Pen
WoW System

- Pass through design into and out of night paddocks - speed problematic
- RFID tag associates weights with individuals

Portable WoW Station

- Baited with salt, molasses
- One way in, one way out
- Decreases stress
- Solar power allows for remote use
- Set up & take down ~ 15 minutes
- Transported in pickup bed

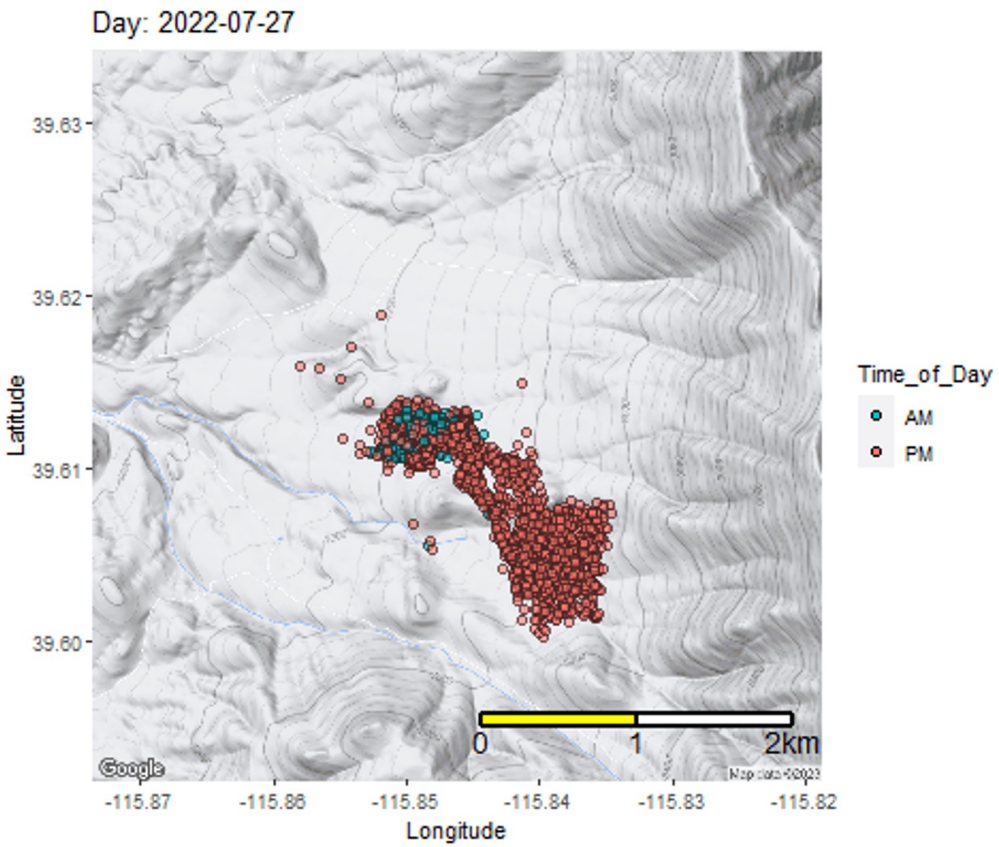
Precision Livestock Farming Data Integration

Integration:

- WoW station data
- Climate data
- Remotely sensed vegetation
  - Grazing efficiency
- Informs flock management decisions

Genetic Analysis:

- Estimate heritability & repeatability
- GWAS



Thank you!

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