Using GPS to Analyze Behavior of Domestic Sheep

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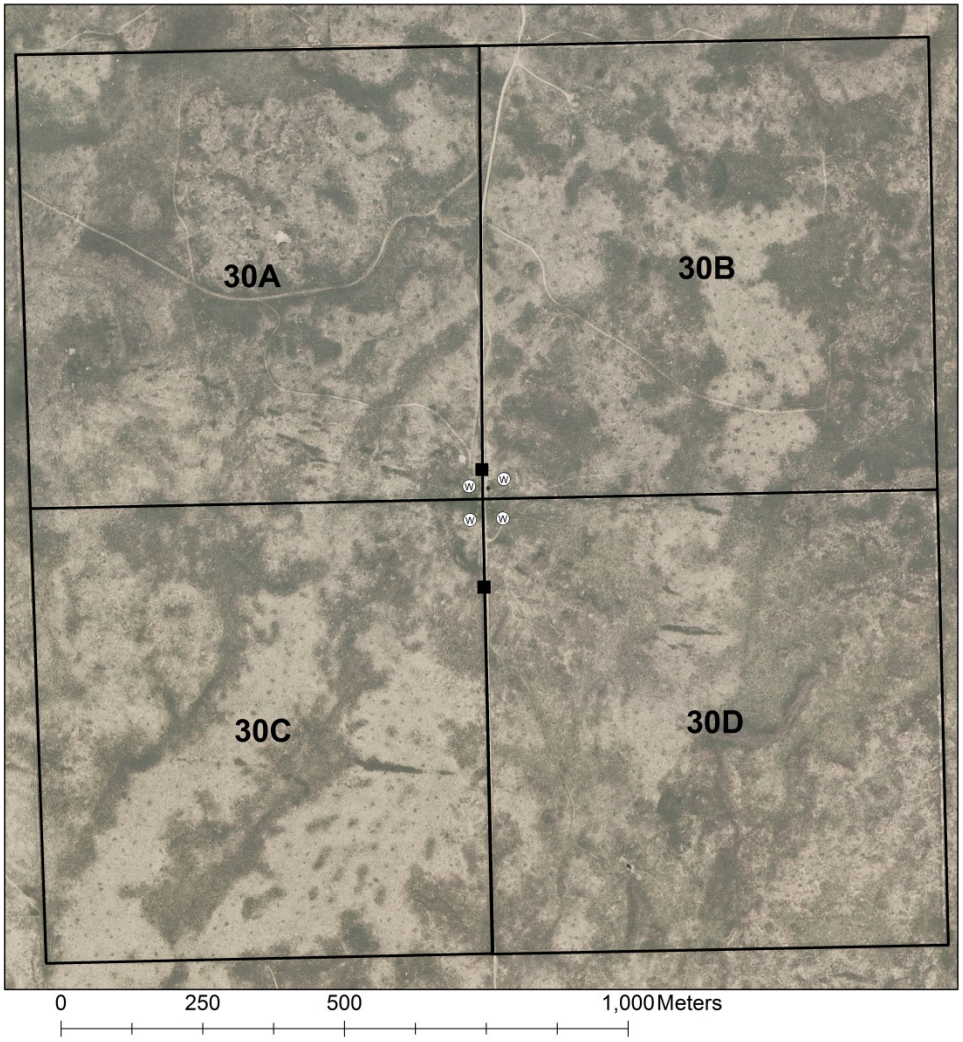
Importance of Study

- Predators use domestic livestock as a food source
  - Predation on domestic livestock effects economics and overall production
  - Some predators are protected and lethal control is not an option (Wolves/Grizzly Bear)
- Predation deterrent techniques can be effective at reducing predation
  - May cause reduce lambing/calving weights
  - May cause lower summer weight gains

Focus of Study/Questions

- Is there a change in daily distance traveled by domestic sheep when in the presence of LGDs? (Distance Study)
- Is there a change in velocity of sheep when in the presence of LGDs? (Velocity Study)
- Is GNSS technology viable for animal movement studies?



Legend

- dog food
- water/mineral

Study Area

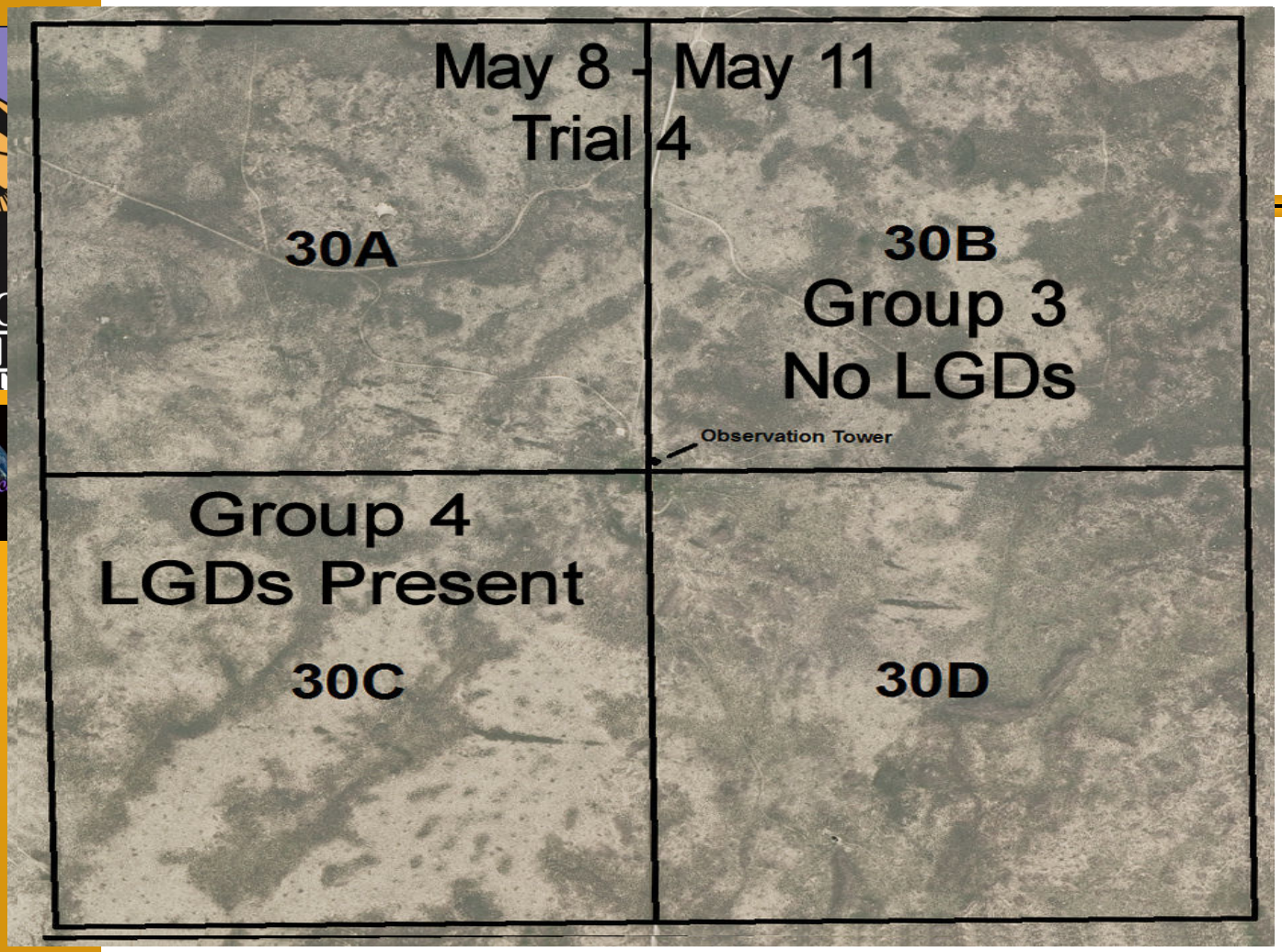
- United States Sheep Experiment Station (USSES)
  - 19,558 ha of land mostly in Idaho but also in Montana
  - Manages approximately 3,000 adult sheep with attending young
    - Sheep within the USSES are exposed to predation by grizzly bears, black bears, mountain lions, grey wolves, and coyotes.

Methods

- Approximately 560 ewes used
- Four groups of approximately 140 ewes
  - Approximately 15 in each group were fitted with GNSS receivers mounted on collars (two types of collars were used)
  - Collected data at 1 second intervals

Methods

- Four trials, approximately 3 days each
  - Approximately one day of acclimation
  - Two 24-hour periods for analysis

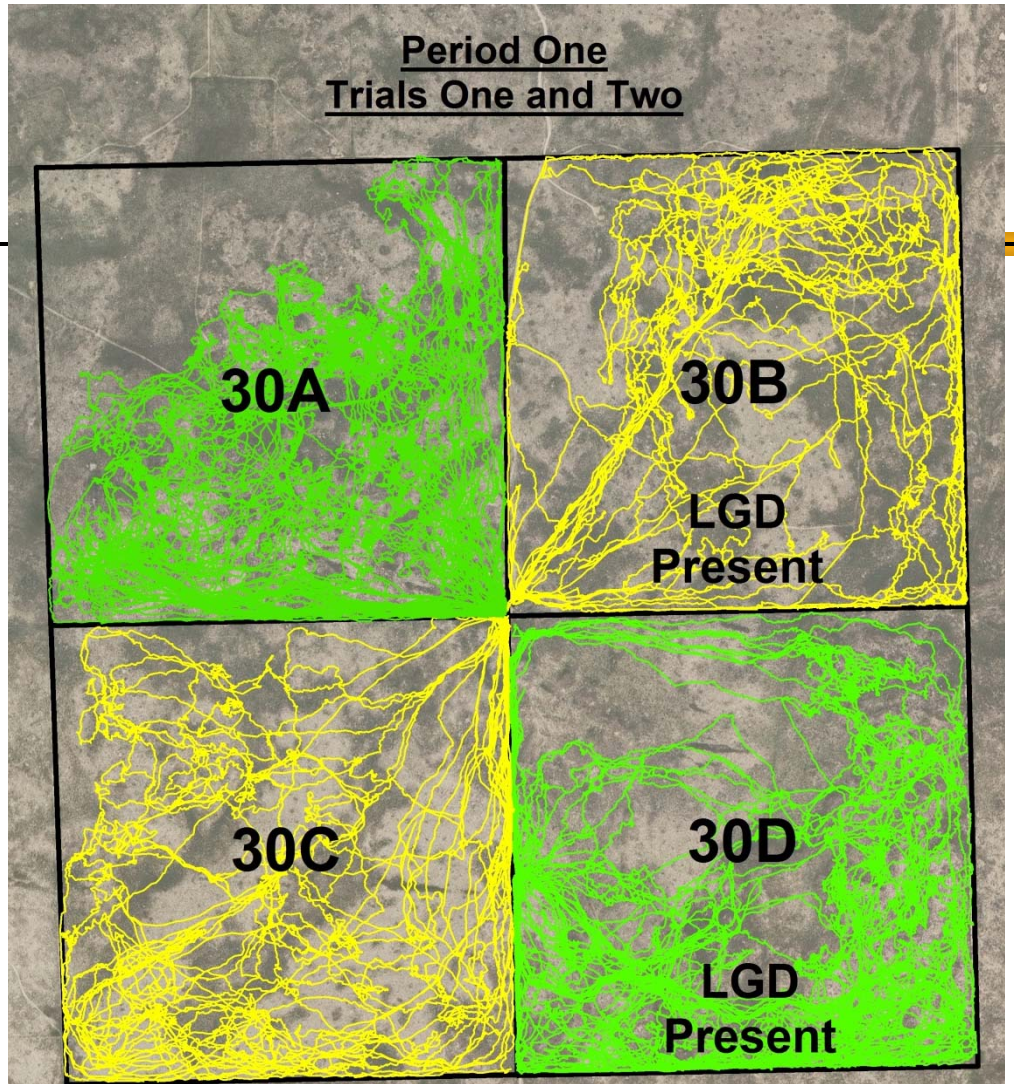

May 8 - May 11
Trial 4
30A
30B
Group 3
No LGDs
Observation Tower
Group 4
LGDs Present
30C
30D

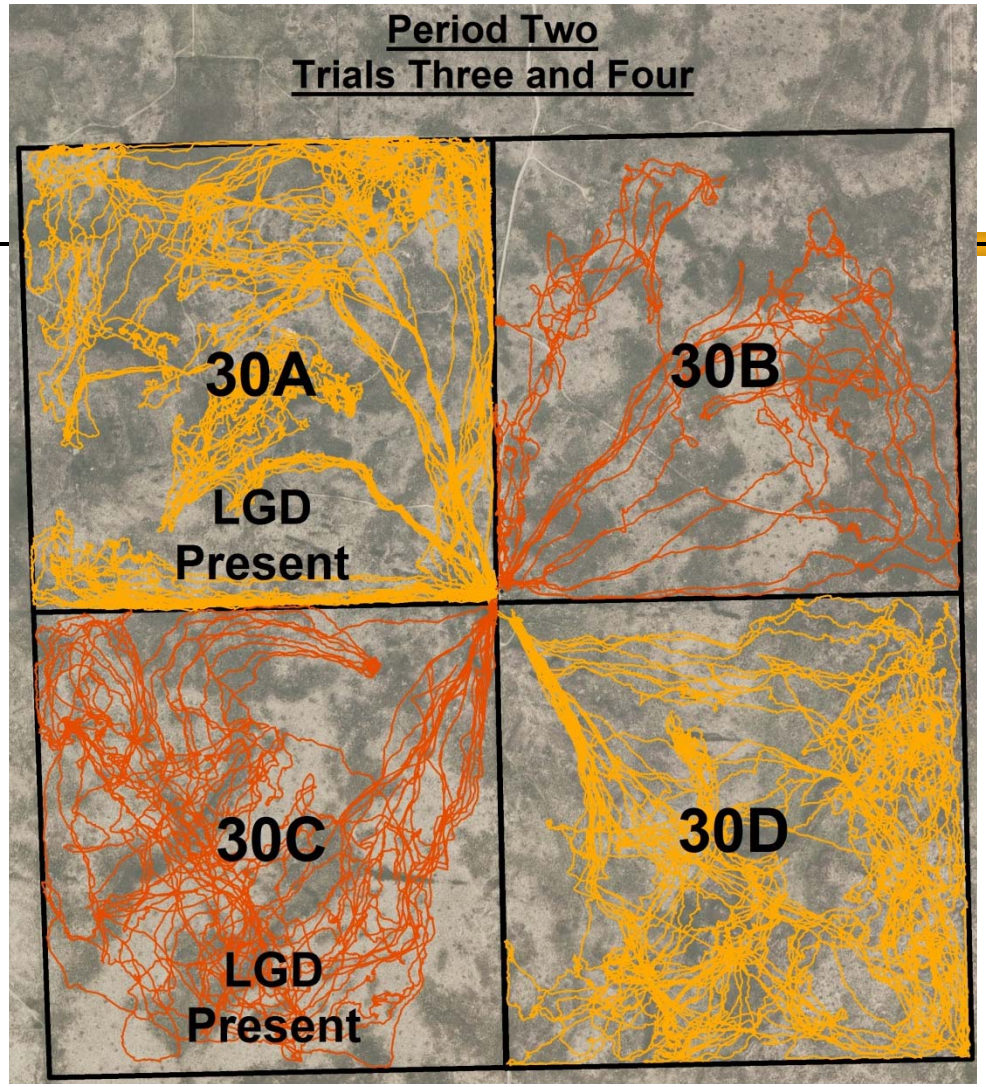
Distance Traveled Study

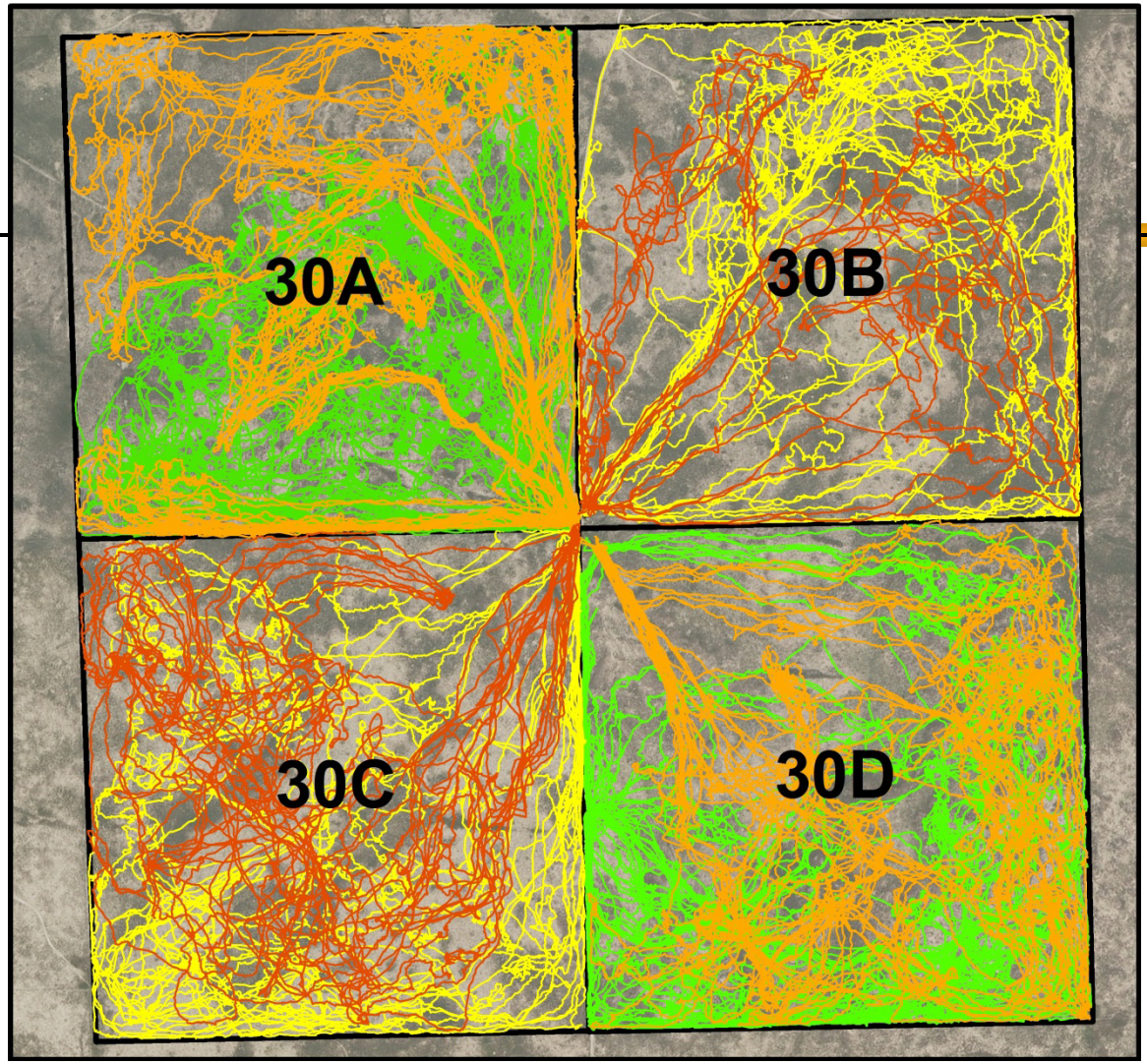
- Methods
  - Took .csv files in Microsoft Excel and sorted fields to find and delete unreal values
  - Imported .csv files into ArcGIS as XY tables
  - Lat/Long WGS 1984
  - Projected into IDTM NAD 1983
  - Created lines from points (chronologically)
  - Erased vertices within one meter of the next one using the Generalize tool in ArcMap
  - Length (distance) of the polyline was used for analysis

Distance Traveled

- Methods
  - Mixed Procedure (PROC MIXED) statement was built it SAS statistical software to evaluate repeated measures
    - Parameters
      - Individual sheep were the sample units
      - LGD presence/absence, day of trial, and collar type were fixed effects
      - Period was the repeated measure
        - Trials 1 and 2 were Period 1, Trials 3 and 4 were Period 2
        - Period 1 and 2 were independent
      - Period was treated as random effect
      - Tukey-Kramer adjustment to account for unequal sample sizes


Period One
Trials One and Two
30A
30B
LGD
Present
30C
30D
LGD
Present


Period Two
Trials Three and Four
30A
LGD
Present
30B
30C
LGD
Present
30D


30A
30B
30C
30D

Distance Traveled

- Results

Effect	P-Value
LGD	0.01
Day of Trial	0.8565
LGD*Day of Trial	0.0119
Collar Type	<0.0001
LGD*Collar Type	0.8911
Day of Trial*Collar Type	0.8409
LGD*Day of Trial*Collar Type	0.9915

Distance Traveled

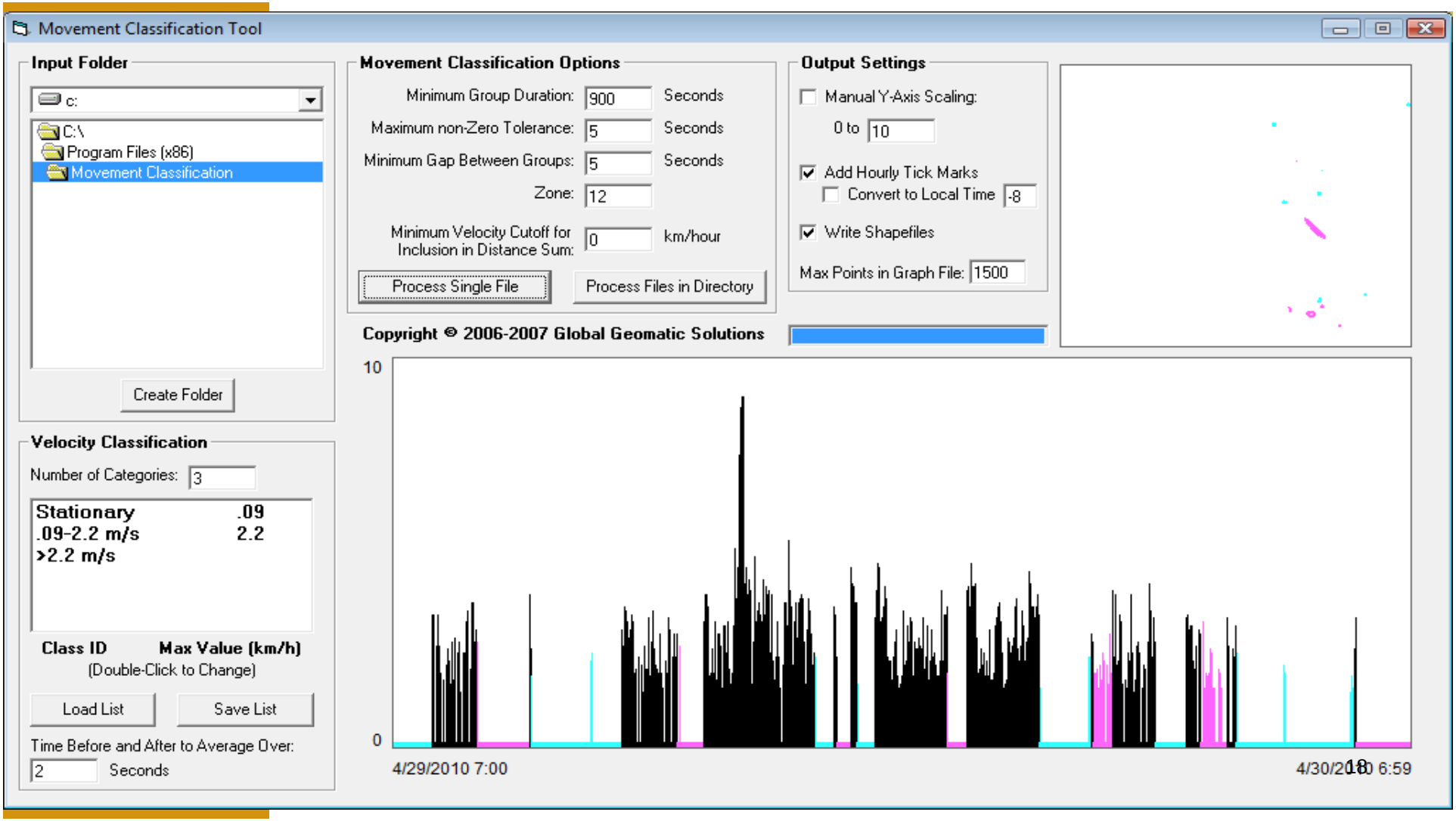
- Discussion
  - Implications- Only day 2 is significant

Effect	LGD	Day of Trail	Average Distance in Meters
LGD	Absent		7156.53
LGD	Present		7863.72
LGD*Day of Trail	Absent	1	7515.39
LGD*Day of Trail	Absent	2	6797.68
LGD*Day of Trail	Present	1	7517.28
LGD*Day of Trail	Present	2	8210.17

When LGDs are present distance increases.
When LGDs are absent distance decreases.

Velocity Study

- Methods
  - Prepared in Microsoft Excel
  - Used KRESS tools to remove unreal high velocities
    - Velocities >9 m/s or approximately 20 mph
      - No more than 196 points removed from one data set (0.23%, most under 100)
  - Used Animal Movement Classifier to Create Velocity Classes
    - Thresholds
      - Stationary velocities less than 0.1 m/s
      - Mid velocities 0.1 to 2.2 m/s (up to approximately 5 mph)
      - High velocities above 2.2 m/s


Movement Classification Tool
Input Folder
c:
C:\
Program Files (x86)
Movement Classification
Create Folder
Velocity Classification
Number of Categories: 3
Stationary .09
.09-2.2 m/s 2.2
>2.2 m/s
Class ID Max Value (km/h)
(Double-Click to Change)
Load List
Save List
Time Before and After to Average Over:
2 Seconds
Movement Classification Options
Minimum Group Duration: 900 Seconds
Maximum non-Zero Tolerance: 5 Seconds
Minimum Gap Between Groups: 5 Seconds
Zone: 12
Minimum Velocity Cutoff for Inclusion in Distance Sum: 0 km/hour
Process Single File
Process Files in Directory
Output Settings
Manual Y-Axis Scaling:
0 to 10
Add Hourly Tick Marks
Convert to Local Time -8
Write Shapefiles
Max Points in Graph File: 1500
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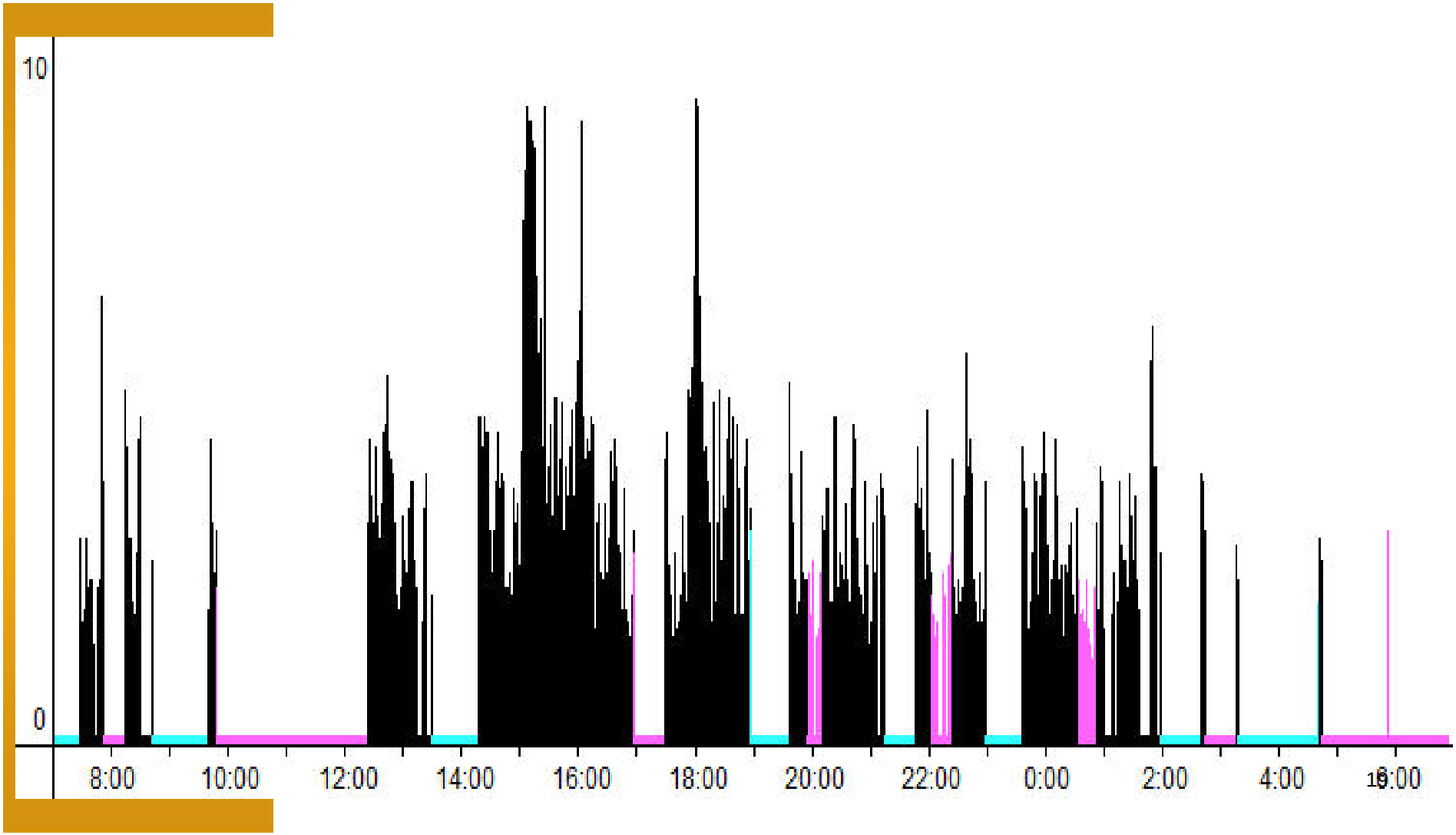
10
0
4/29/2010 7:00
4/30/2010 6:59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8:00
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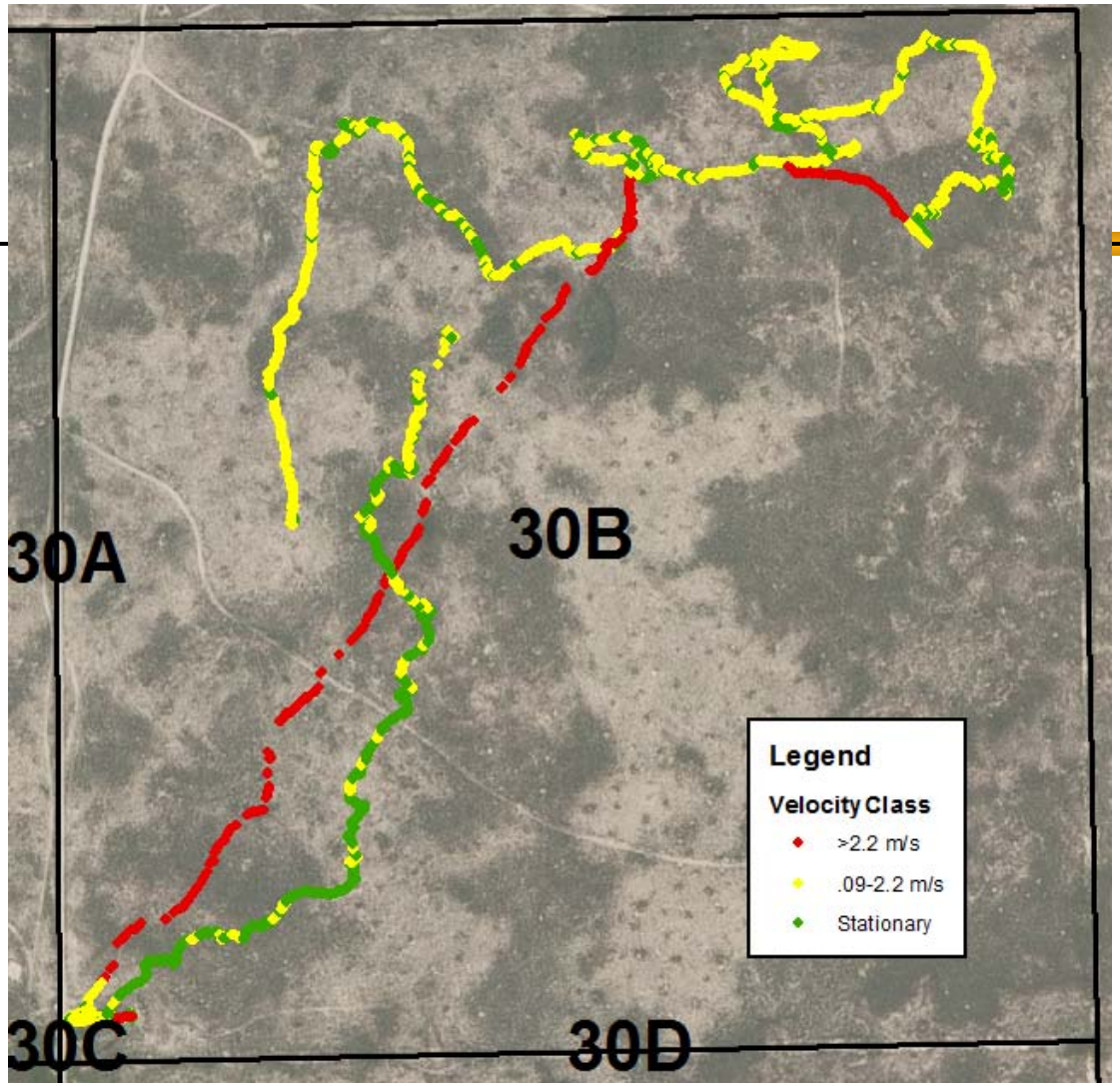
20:00
22:00
0:00
2:00
4:00
6:00

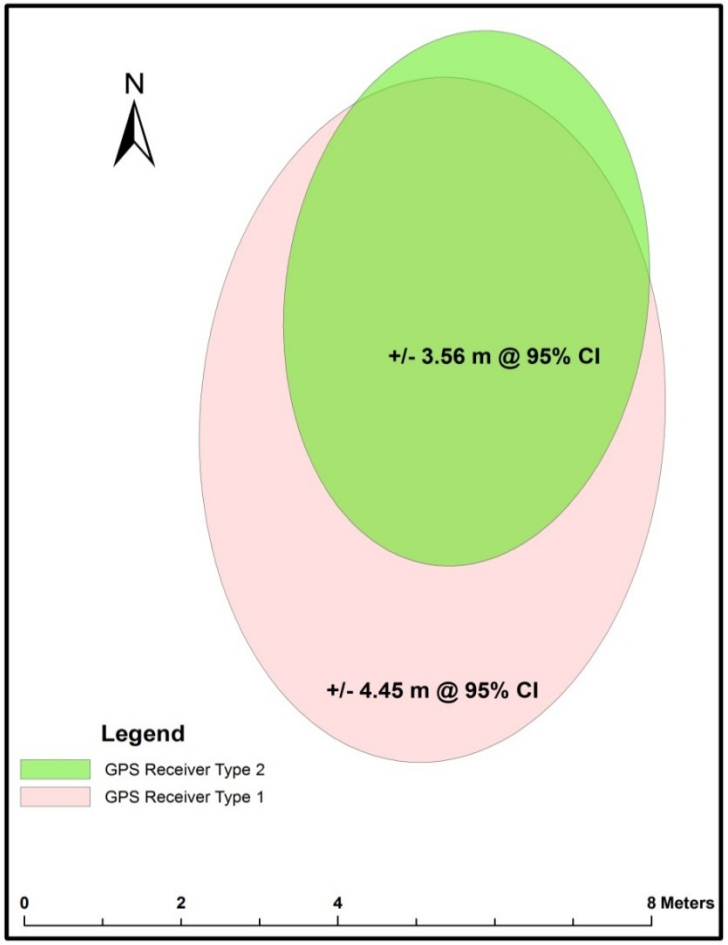

30A
30B
30C
30D
Legend
Velocity Class
>2.2 m/s
.09-2.2 m/s
Stationary

Velocity Study

- Results
  - Used same parameters for PROC MIXED as in Distance Study
    - Found no difference in percent time spent at each velocity class between sheep with LGD's present and sheep without LGDs present

GNSS Use

- Challenges
  - Amount of points/ frequency of collection
    - More than ten million points
    - Collected at 1 sec intervals
  - Used Generalize tool
  - Uneven data sets/ receivers dying
  - Resampling of groups (Statistics)
  - Converting data to usable format


N
+/- 3.56 m @ 95% CI
+/- 4.45 m @ 95% CI
Legend
GPS Receiver Type 2
GPS Receiver Type 1
0
2
4
8 Meters

Conclusion

- When LGDs are present sheep travel farther
- Even though sheep travel farther when LGDs are present they do not spend a greater amount of time at high rates of speed.
  - May spend more time foraging and less time being attentive (not distinguishable by velocity data)
- High frequency GNSS point data can be used to analyze animal movements as long as some challenges are not overlooked
  - e.g.- receiver failure, battery failure, sample sizes, positional jump

Acknowledgments

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Questions?