Portable Goat Shelters:

Goat Preferences for Cover Type and Deck Number

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Photo by Dawn Schlund

Topics for Today

- Introduction
- Hypotheses
- Experimental Design
- Ethogram
- Statistical Analysis
- Results
- Discussion
- Conclusion
- Future Studies
- References

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Brush Management[1]

- Prescribed Fire

- Mechanical

- Chemical

- Biological

- Timing
- Intensity
- Frequency
- Duration

[1]Hart, 2004

Kay Ledbetter

Rich Walton

DCNR, 2002

Katie Baumann

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Goats for Brush Control

- Goats are a feasible alternative to chemical or physical control of invasive vegetation[1]

- Plant damage by livestock: not timing of grazing applications. Is duration and intensity[2]

- Stripping of bark by goats will kill woody vegetation >7 feet tall[3]

[1]Distel and Provenza, 1991; [2]Hart, 2004; [3]Mitchell, 1996

Photo by C. Nolden, 2011

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Economics: WI Contract Browsing

- April 15 to November 1
- Hourly rate $25-60
- Delivery charge $100-200/trip
- Head/Day charge $2-3.00

- Contractor provides:
  - Fences/Energizer/Battery
  - Goats
  - Water tank
  - Mineral feeder & mineral
  - Labor

- Example[1]
  - 15 ac woodland
  - 1 week (7 d)
  - 200 goats ($2.00)
  - 8 deliveries ($150)
  - Labor for 5 ac paddocks (3 moves)
    - 5 hr setup, 3 hr move x 2 ($35)

$3,895 charged/week

Winter too???

[1]Bennett, 2014

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Before
1.5 acre paddock

After
3 days
110 goats

Photos by Cherrie Nolden, Yellowstone Lake Wildlife Area, WDNR, Blanchardville, WI

Paddock Move

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Honeysuckle

Photo by C. Nolden, 2013

Red Cedar

Photo by C. Nolden, 2014

Multiflora Rose

Photo by C. Nolden, 2014

Autumn Olive

Photo by C. Nolden, 2014

Autumn Olive

Photo by C. Nolden, 2014

Honeysuckle

Photo by C. Nolden, 2014
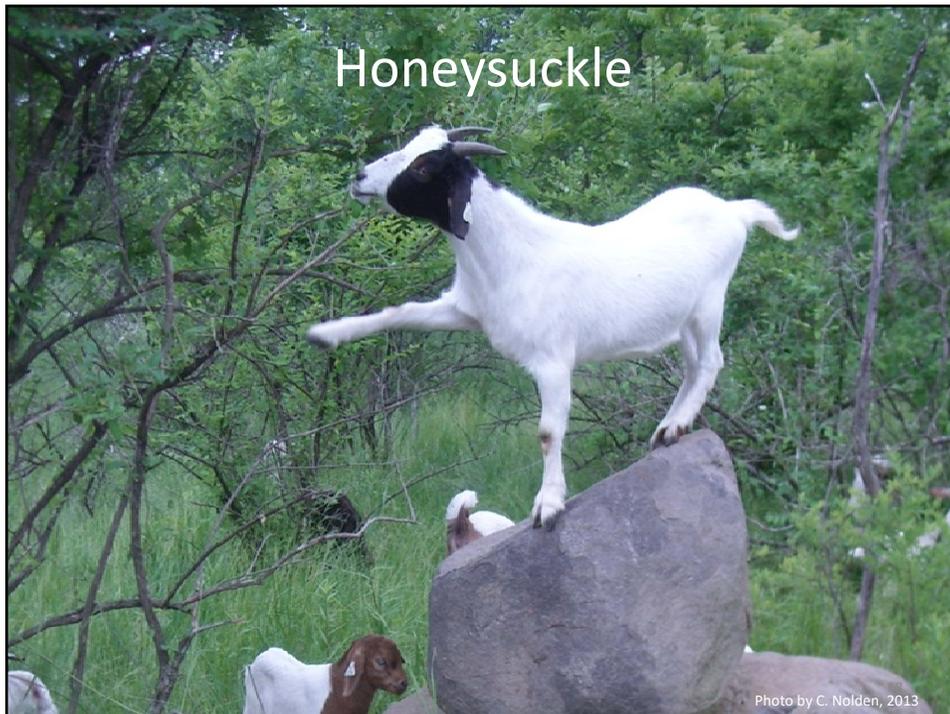

Shelter

Photo by C. Nolden, 2011

Shelter

Photo by Appleton Creamery, 2015

My Thought Process

- Need portable shelters for goats
- No research on cold-weather portable shelters
- What kind of design would be cheap, durable, highly portable?
- What factors can I manipulate to help make a better shelter for the goats?
- What factors influence goat use of the shelters?
- How can I test my ideas?

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Shelter Considerations

Goats

- Herd animal, sleep together[1]
- 16 sq ft/goat: AWA[2]
- High sites, good visibility[3]
- Intolerant of cold, wet and wind[4]
- Move toward light[5]
- Don't need fancy shelter[7], but do need shelter[8]

Shelters

- Open-sided for ventilation[6]
- Draft prevention with plastic shell, solid floor[6]
- Cost of shelters
  - Opaque cover = $25
  - Transparent cover = $108
  - Single Deck = $650
  - Double Deck = $775

[1]Leidy et al., 2015; [2]AWA, 2015; [3]Aschuanden et al., 2009; [4]Welch, 2011; [5]Grandin, 1980; [6]Harmon and Hoff, 1994; [7] Anderson and Boe, 2007; [8]Lee et al., 1940.

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Hypotheses of Goat Preferences

- H_0: Opaque covers = Transparent covers
  H_a: Opaque covers < Transparent covers

- H_0: Double deck = Single deck
  H_a: Double deck < Single deck

- H_0: Temperature no effect
  H_a: Colder increases goat use of preferred shelter

- H_0: Day preference = Night preference
  H_a: Different preference by Day or Night
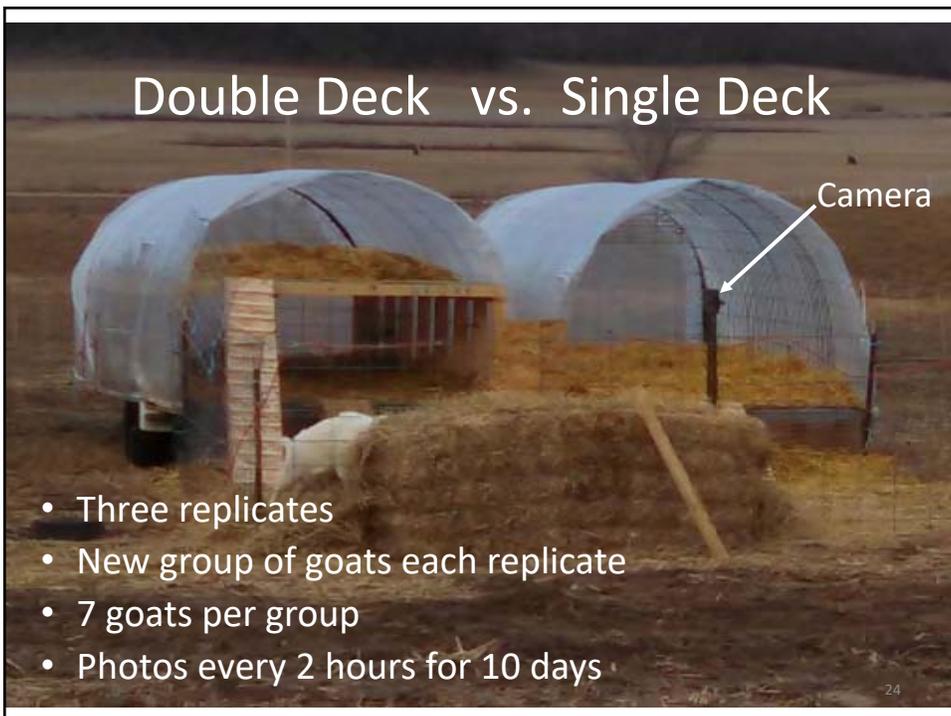
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Single Deck Shelters

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Double Deck Shelters

Solid Floors

Transparent or Opaque Covers
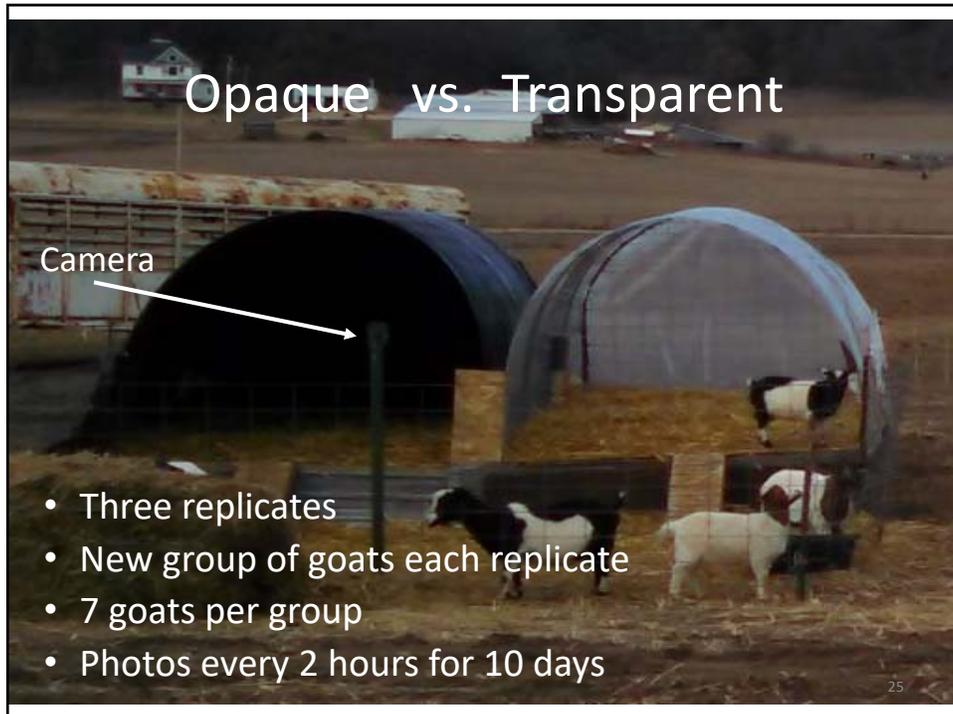

Double Deck   vs. Single Deck

Camera

- Three replicates
- New group of goats each replicate
- 7 goats per group
- Photos every 2 hours for 10 days

Opaque   vs. Transparent

Camera

- Three replicates
- New group of goats each replicate
- 7 goats per group
- Photos every 2 hours for 10 days

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Day Photo

MOULTRIE 27°F   GROUP 1 CAM   31 DEC 2014 01:52 pm

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Night Photo

Experimental Design 1: Statistics

- Repeated Measures ANOVA (Split Plot in Time Analysis, within Day) [1]
  - Whole Plot Randomized Complete Block Design
    - Block is Group (EU); N=3 for each treatment
    - Goat groups randomly assigned to the treatment (D vs. S, O vs. T)
    - Analyzed Day by Day; 10 days for each Group
  - Split is Time of day
    - 2-hour time-lapse picture data; (0200, 0400, 0600….2400)
    - Missing pics – Condense: Early AM, Mid AM, Early PM, Late PM
  - Time is the repeated measure
  - Response is Ave # Goats
  - Autocorrelated errors: sp(pow) error structure
    - Evenly spaced data points

[1] Crump, 2015

Experimental Design 1: Analysis

SAS Code[1]:

```
proc mixed; class trt group nnhour;
model count = temp  trt nnhour trt*nnhour;
random group trt*group;
repeated / subject=trt*group type=sp(pow)(time);
lsmeans trt nnhour trt*nnhour / diff;
 ods output diffs=ppp lsmeans=mmm;
 ods listing exclude diffs lsmeans;
 run;
```

%include
'C:\Users\canolden\Documents\SAS_SID_94_2016\pdmix800.sas';

%**pdmix800**(ppp,mmm,alpha=**.05**,sort=yes); [2]

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[1] Crump, 2015; [2] Saxton, 1998

Experimental Design 2: Statistics

- Repeated Measures ANOVA (Split Plot in Time Analysis) [1]
    - Whole Plot Randomized Complete Block Design
        - Block is Group (EU); N=3 for each treatment
        - Goat groups randomly assigned to the treatment (D vs. S, O vs. T)
        - Analyzed Day by Day; 10 days for each Group
    - Split is Day of the paired preference test
        - 2-hour time-lapse picture data; (0200, 0400, 0600….2400)
        - Separated by Night vs Day
        - Night-time photo counts of goats averaged by day
    - Day is the repeated measure
    - Temp is averaged, mean of picture times
    - Response is Ave # Goats, mean of picture times
    - Autocorrelated errors: sp(pow) error structure
        - Evenly spaced data points

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[1] Crump, 2015

Experimental Design 2: Analysis

SAS code[1]

```
proc mixed; class trt group day;
model count = temp  trt day trt*day;
random group trt*group;
repeated / subject=trt*group type=sp(pow)(time);
lsmeans trt day trt*day / diff;
 ods output diffs=ppp lsmeans=mmm;
 ods listing exclude diffs lsmeans;
 run;

%include
'C:\Users\canolden\Documents\SAS_SID_94_2016\pdmix800.sas';

%pdmix800(ppp,mmm,alpha=.05,sort=yes); [2]
```

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[1] Crump, 2015; [2] Saxton, 1998

Ethogram

Treatment	Group	Day	Hour	Temp-F	DN	Cat1	Cat2	Difference
OT	1	2	2	11	Night	3	0	3
OT	1	2	4	9	Night	5	0	5
OT	1	2	6	7	Night	7	0	7
OT	1	2	8	5	Day	7	0	7
OT	1	2	10	18	Day	2	3	-1
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
OT	4	3	2	22	Night	4	0	4
OT	4	3	4	20	Night	2	1	1
OT	4	3	6	20	Night	4	0	4
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
SD	3	2	2	11	Night	0	4	-4
SD	3	2	4	9	Night	0	4	-4
SD	3	2	6	7	Night	0	3	-3
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
SD	5	4	18	33	Night	0	2	-2
SD	5	4	20	33	Night	0	4	-4
SD	5	4	22	32	Night	0	4	-4
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

- 621 photographs
- Treatment is the pair of Opaque vs Transparent (OT), or the pair of Single vs. Double deck (SD)
- Group is the set of 7 goats assigned to the replicate (1-6)
- Day is the day of the preference test (1-10)
- Hour is the time of the pic
- Temp is the camera-recorded temp for that pic in °F
- DN is whether it was Day or Night in the pic
- Cat1 = count of goats in the first of the treatment pair (O for O vs. T; S for S vs. D)
- Cat2 = count of goats in the second of the treatment pair (D for S vs. D; T for O vs. T)
- Difference is the Sign Test calculation of the Cat1-Cat2 goat count

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Analysis 1 Results – by Hour

Treatment	Estimate	Standard Error	Letter Group*
Opaque	**4.2847**	0.1797	A
Transparent	0.4306	0.1797	B
Double	**2.9343**	0.6458	A
Single	1.1184	0.6458	A

* Different Letter Group indicates Significance at P < 0.05

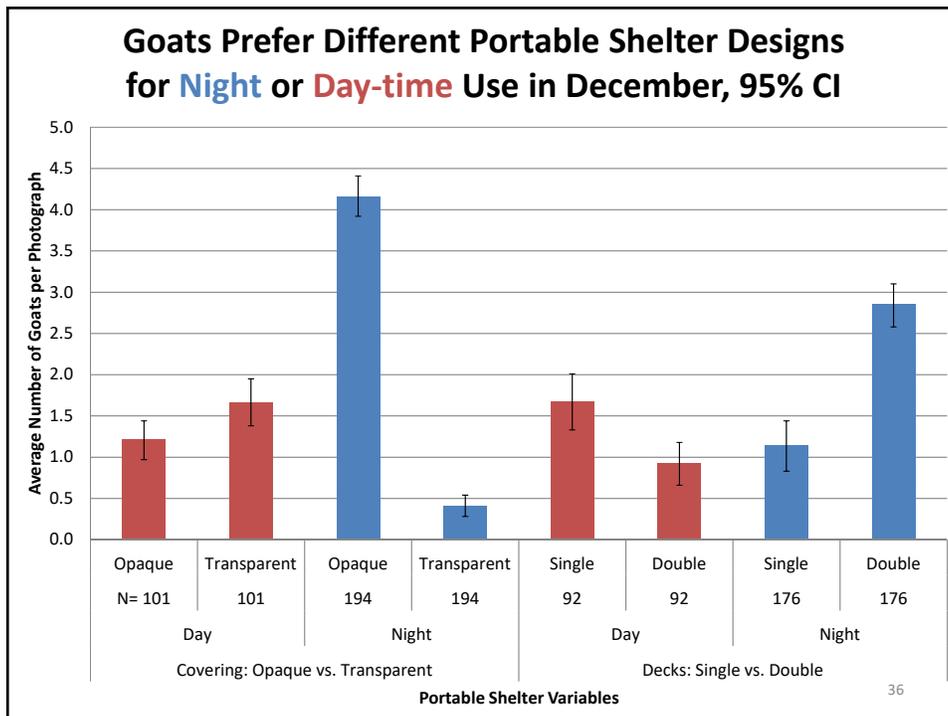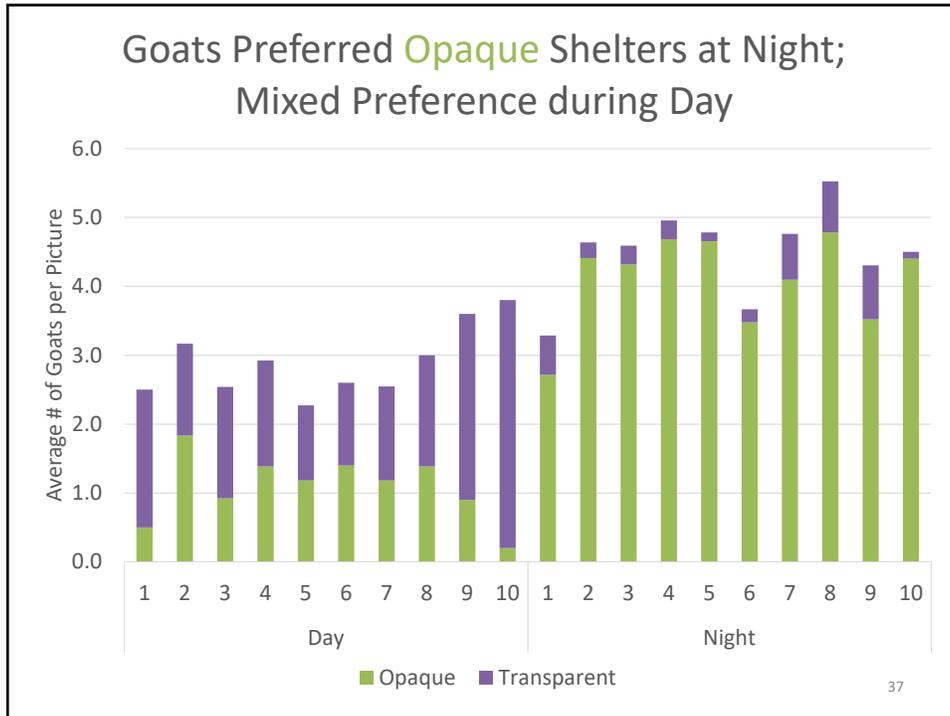| Opaque vs Transparent Type 3 Tests of Fixed Effects					Double vs Single Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F	Effect	Num DF	Den DF	F Value	Pr > F
Temp	1	59	0.63	0.4323	Temp	1	51	0.32	0.5755
Trt	1	2	244.57	**0.0041**	Trt	1	2	3.96	0.1847
Hour	15	59	0.63	0.8398	Hour	15	51	0.48	0.9414
Trt*Hour	15	59	0.94	0.5285	Trt*Hour	15	51	2.33	**0.0126**

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Analysis 2 Results – by Day

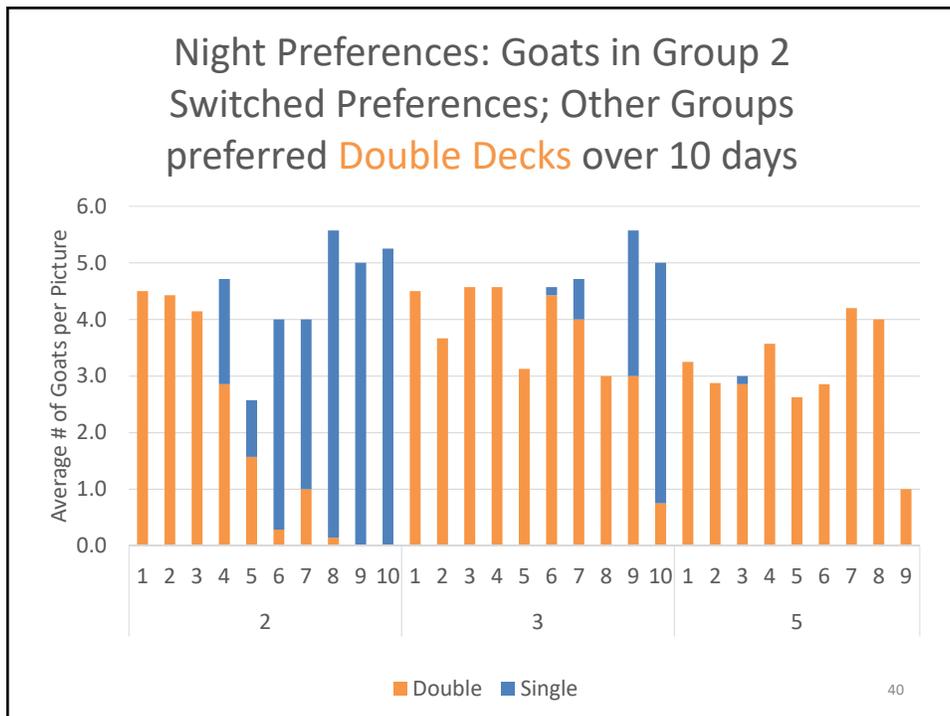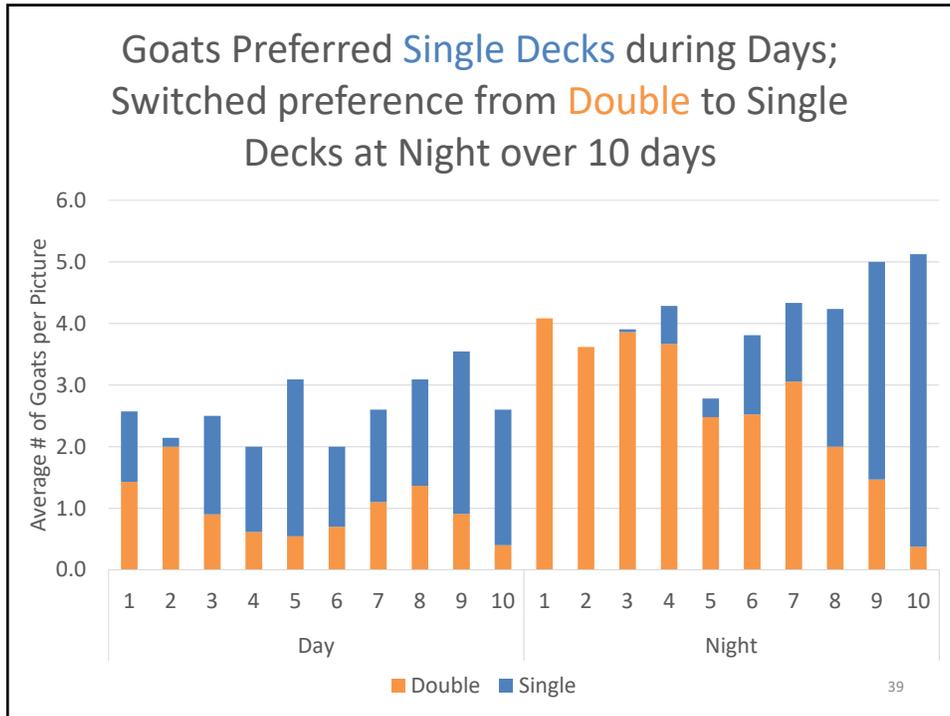| Treatment	Estimate	Standard Error	Letter Group*
Opaque	**4.2986**	0.2198	A
Transparent	0.4479	0.2198	B
Double	**3.0438**	0.7230	A
Single	1.1118	0.7230	A

* Different Letter Group indicates Significance at P < 0.05

Opaque vs Transparent Type 3 Tests of Fixed Effects					Double vs Single Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F	Effect	Num DF	Den DF	F Value	Pr > F
Temp	1	27	0.54	0.4702	Temp	1	25	0.30	0.5892
Trt	1	2	153.50	**0.0065**	Trt	1	2	3.57	0.1993
Day	7	27	0.69	0.6775	Day	7	25	0.48	0.8411
Trt*Day	7	27	0.69	0.6768	Trt*Day	7	25	1.69	0.1578

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Goats Prefer Opaque Covers and Double Decks on Portable Shelters Used in December, 95% CI

Goats Prefer Different Portable Shelter Designs for Night or Day-time Use in December, 95% CI

Goats Preferred Opaque Shelters at Night; Mixed Preference during Day

Goats Preferred Opaque Shelters at Night; Mostly Consistent between Groups

Goats Preferred Single Decks during Days; Switched preference from Double to Single Decks at Night over 10 days

Night Preferences: Goats in Group 2 Switched Preferences; Other Groups preferred Double Decks over 10 days

Discussion of Goat Preferences

- H_0: Opaque covers = Transparent covers
  H_a: Opaque covers $>$ Transparent covers

- H_0: Double deck = Single deck
  H_a: Double deck $>$ Single deck   (trend)

- H_0: Temperature no effect
  H_a: Colder increases goat use of preferred shelter

- H_0: Day preference = Night preference
  H_a: Different preference by Day or Night   (trend)

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Discussion

- Night is the focus time; when goats seek shelter
- Group 2 unique?
- Bedding cause preference switch?
- Surprisingly strong preferences

- Interaction strong
- Opposite preferences of expectation
- N=3, 6 better
- Missing photos
- Visibility of goats in pics
- Crossover design better
- Ramps wider

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Conclusions

- Reject the Null for Cover Type, Deck Number and Day/Night
  - Goats prefer Opaque covers to Transparent covers at Night (strong preference)
  - Goats prefer Double Deck shelters to Single Deck shelters at Night (trend)
- Cannot reject the Null for Temperature
  - Temperature didn't influence goat preference of shelter covers or deck number

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Future Studies

- Repeat the study
  - At least 6 replicates
  - Crossover design (control group effect)
  - Over a longer period of time (through winter)
  - Consider Temp, Wind, Precipitation
  - Health (BW, BCS, symptomatic disease)
  - Agonistic behavior differences (displacements, threats, butting)
  - Comfort (lying bouts, time, location)
- In the Opaque Double Deck shelters, at Night:
  - Increasing density: 1.5x 2x, 2.5x (low, med, med-high[2])
  - Longer time observed
  - Health, agonistic behavior, comfort
  - Visual barriers[1], Wall space[2]

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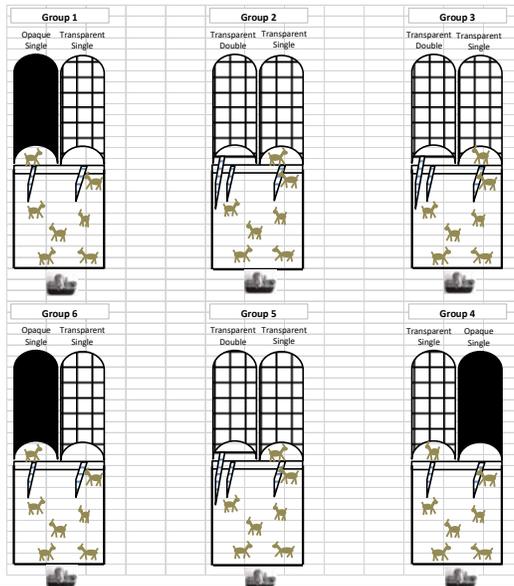[1] Aschwanden et al., 2009; [2] Anderson and Boe, 2007

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Questions?

Experimental Design - Layout