November 1, 2017

Ron & Theresa Miskin, The Buffalo Wool Co.
604 Joy Ln.
Kennedale, TX 76060
Sales@thebuffalowoolco.com
(802) 379-9665

Dear Ron and Theresa,

I want to thank you for providing great gear towards my research that I used during the last summer and will use again this winter.

As you may recall, my summer and winter trips total 19,000 miles of driving from Saskatchewan to Texas. This summer, I tested out the thinner set of bison/merino casual dress wear socks and took some thermal imagery of their performance against a Hanes cotton crew socks. This particular day was hot and humid in August, just outside of College Station, TX where I was conducting some of my fieldwork under moderate exertion. I found the wool blend casual socks to be of great use in wicking sweat away from my foot creating a cooling effect.

I look forward to trying out the heavier winter socks this coming winter for their insulative properties. I have high hopes that they will be very warm and comfortable. I will be in Saskatchewan to test them out this coming late-December and early-January.

I wanted to share with you, one image that I captured this summer of a bison bull at one of my 19 locations in Montana to illustrate the utility of thermal imagery (Figure 1).

Figure 1. Thermal and photo of bison bull. "Hot Bull on the Hill." Left, an infrared thermal image of a bison bull in Montana. Lighter colors indicate warmer areas whereas darker colors represent cooler temperatures. Right, a photograph of the same bull at the same instant for comparison. Photos taken June 29, 2017.

Sincerely,

Jeff M. Martin, BS, MS | PhD Student
Research Fellow | Barboza Lab of Wildlife Conservation & Policy
Department of Wildlife and Fisheries Sciences | Texas A&M AgriLife Research

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Infrared thermal comparison of textiles during summer use: bison/merino wool blend and 100% cotton socks

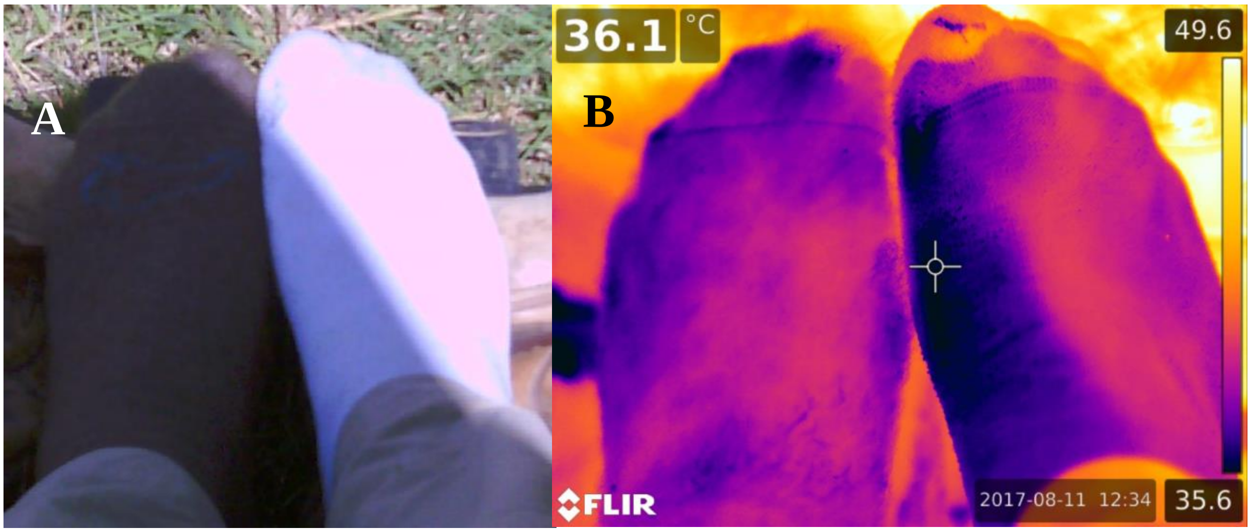

Figure 2. Side by side comparison. Left image (A) is visible spectrum photo, right photo (B) is longwave infrared thermal image. Within each image (A & B): left foot is the wool sock (100.8 ± 1.1°F (38.2 ± 0.6°C), ε = 0.92); whereas the right foot is the Hanes cotton sock (104.7 ± 2.5°F (40.4 ± 1.4°C), ε = 0.80).

Introduction & Study Design

Bison/merino (sheep) wool blend casual crew socks (Figure 2) were provided in-kind by The Buffalo Wool Co., Kennedale, Texas for field trials comparing standard Hanes cotton crew cut socks for cooling effect. To limit environmental condition variance, the author wore one bison/merino wool blend sock on the left foot and one Hanes cotton sock on the right foot. Slight to moderate exertion of activity was applied during the hot (97°F) and humid (50%) conditions during midday in southeast central Texas during early August of 2017.

Environmental Conditions

Geospatial & temporal summary:

Lat/long: N 30°41’, W 96°27’ – Southeast/Central Texas

Date/time: 8/11/2017 11:40–13:40 CT

Weather summary:

Ambient weather measures were taken with a mobile weather station (Kestrel 5400AG Cattle Heat Stress Tracker) on a vane placed 0.25m above ground. Measures are reported in Table 1.

Table 1. Summary of ambient environmental conditions reported during time of study.

Metric (unit)	Calculations (accuracy as reported by Kestrel)	Measure: mean (min—max)
Temperature (°F)	Ambient dry bulb (±0.9)	97 (94—99)
Relative humidity (%)	Wet-Dry bulb difference (±2)	50 (47—52)
Heat index (°F)	Temperature, relative humidity (±7.1)	113 (108—119)
Wind direction (°) and speed (mph)	Cardinal direction* (±5°), impeller velocity (±0.1mph)	174 (south) @ 2 (0—5)
Thermal work limit (W/m^2)	Wind speed, temperature, globe temperature, relative humidity, pressure (±10.9)	94 (80—122)

* Magnetic heading calibrated to True North; magnetic declinations were obtained from https://www.ngdc.noaa.gov/geomag-web/#declination.

Emissivity of Materials

Emissivity (ε) is a measure of a material's radiating efficiency. An emissivity of 1.00 implies that the material is 100% efficient at radiating energy. An emissivity of 0.20 implies that the material radiates only 20% of that which it is capable of radiating. Knowledge of emissivity is critical for directly comparing products. Emissivity values alter the measured temperature, the temperature is reliant upon accurate reports of the emissivity to give the true temperature of the object. With our equipment and software, we found the relative emissivity of the textiles compared in the case study. Generally accepted emissivity values exist in industrial products and are reported in online tables (http://www.optotherm.com/emiss-table.htm).

Emissivity results:

We found that the emissivity of dry thin wool dress socks is 0.92 as compared directly to 3M Black electric tape (ε = 0.96). Other material emissivity values are listed in Table 2.

Table 2. Emissivity (ε) of selected materials used in this study.

Material	Emissivity (ε)
Bison/merino wool (textile)	0.92
3M Scotch Black electric tape	0.96
Cotton (textile)	0.80
Human skin	0.99
Water (liquid)	0.90 - 0.95
Leather	0.95 - 1.00

Thermography

Surface temperature measures were remotely sensed using a high resolution thermographic camera (FLIR T1030sc longwave infrared thermal imaging camera) with a telephoto lens, 12° × 9° lens (f/1.2). The thermal camera senses infrared in the longwave spectrum, 7.5-14 µm in length. The camera is accurate to ±1°C (±1.8°F) or ±1% at 25°C for temperatures between 5°C to 150°C.

Processing imagery:

Photos were analyzed in FLIR ResearchIR Max 4 software (version 4.40.1.6; 64-bit). Regions of interest (ROI) were outlined and calibrated depending on material-specific emissivity values (see table 2) for accurate and precise temperature readings. ROI metrics are reported, including temperature, standard deviation, and respective emissivity used. All images were assumed and set to 20°C for reflected temperature, per industry standards.

Results

Anecdotal observations: the user found the bison wool dress sock to be cooling compared to the Hanes cotton sock. The sweat from the user's feet was wicked to the boot (well-worn, uninsulated leather Ariat cowboy boots; Figure 3). The moisture was then evaporated from the boot.

The wool-wicked moisture soaked through the boot, but likely provided a cooling effect more so than the cotton sock, by about 3°F (Figure 3). The bison/merino socks measured cooler than the cotton sock did, by about 4°F (Figure 4). Interestingly, the left foot (which wore the bison/merino sock) measured hotter than the right (the cotton sock), by about 1.5°F (Figure 5). The measure may be influenced by the higher proportion of residual sweat (water) on the right foot that did not wick away, which would decrease the emissivity, thus skewing the measure to appear cooler than actual.

Although this study lacks unbiased rigor, the preliminary results suggest than wool blend socks may be of better quality during sweltering hot days than cotton. The adage, "cotton kills," comes to mind. In the brisk spring, winter, and autumn months of the North, cotton outer garments are frowned upon due to the absorptive traits to water and are likely the downfall to their performance in comparison to wool, which wicks the moisture away from the origin.

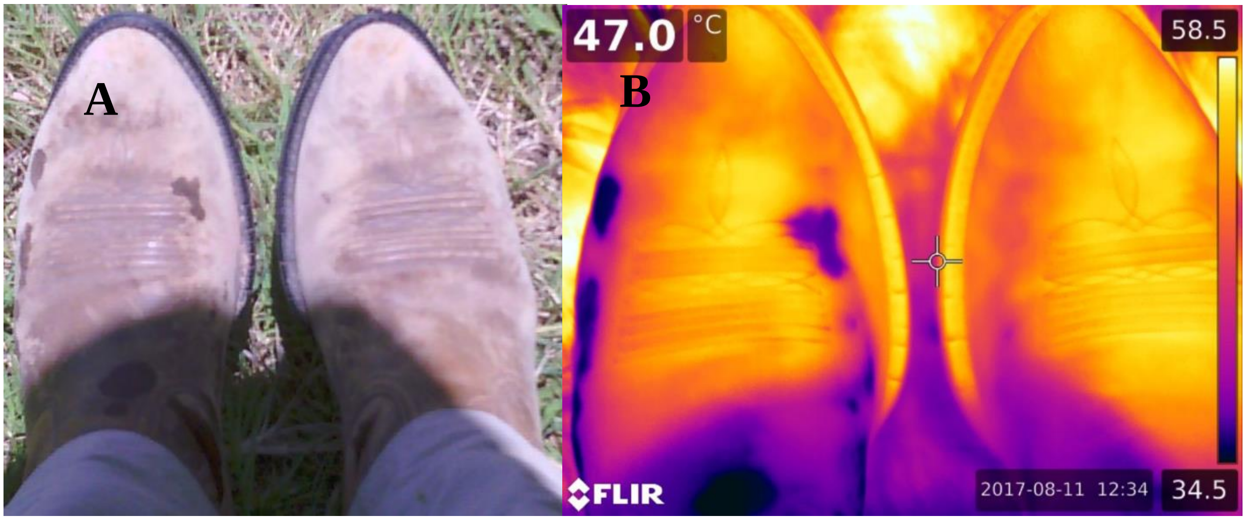

Figure 3. Side by side comparison. Left image is visible spectrum photo, right photo is longwave infrared thermal image. Within each image: left boot is the wool sock (115.3 ± 6.9°F (46.3 ± 3.8°C), ε = 0.97); whereas the right boot is the Hanes cotton sock (118.2 ± 5.6°F (47.9 ± 3.1°C), ε = 0.97). Notice, the right boot (cotton sock) does not have sweat stains (lack of wicking).

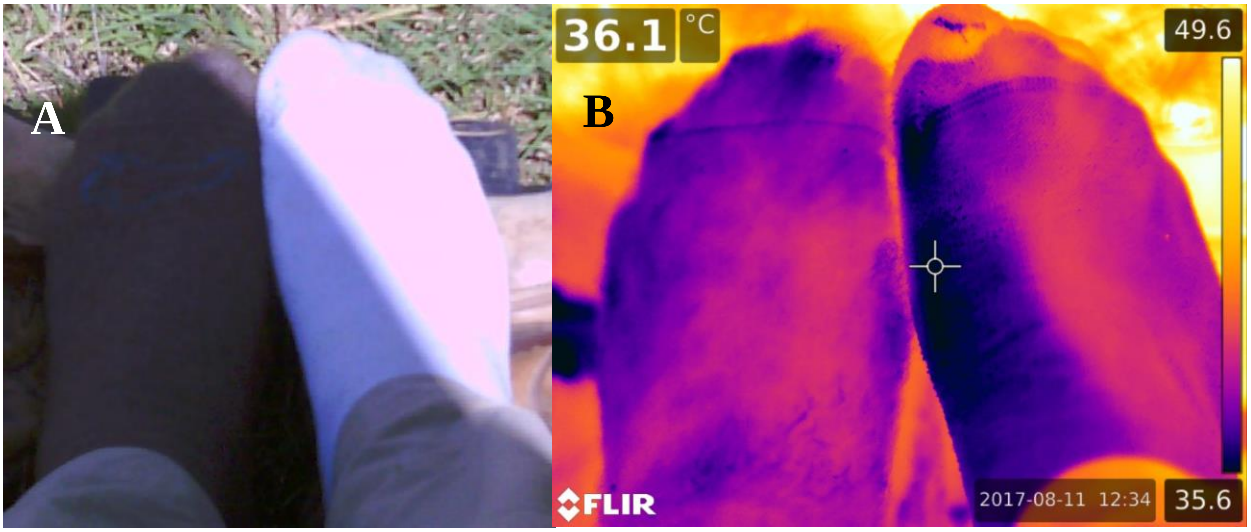

Figure 4. Side by side comparison. Left image (A) is visible spectrum photo, right photo (B) is longwave infrared thermal image. Within each image (A & B): left foot is the wool sock (100.8 ± 1.1°F (38.2 ± 0.6°C), ε = 0.92); whereas the right foot is the Hanes cotton sock (104.7 ± 2.5°F (40.4 ± 1.4°C), ε = 0.80).

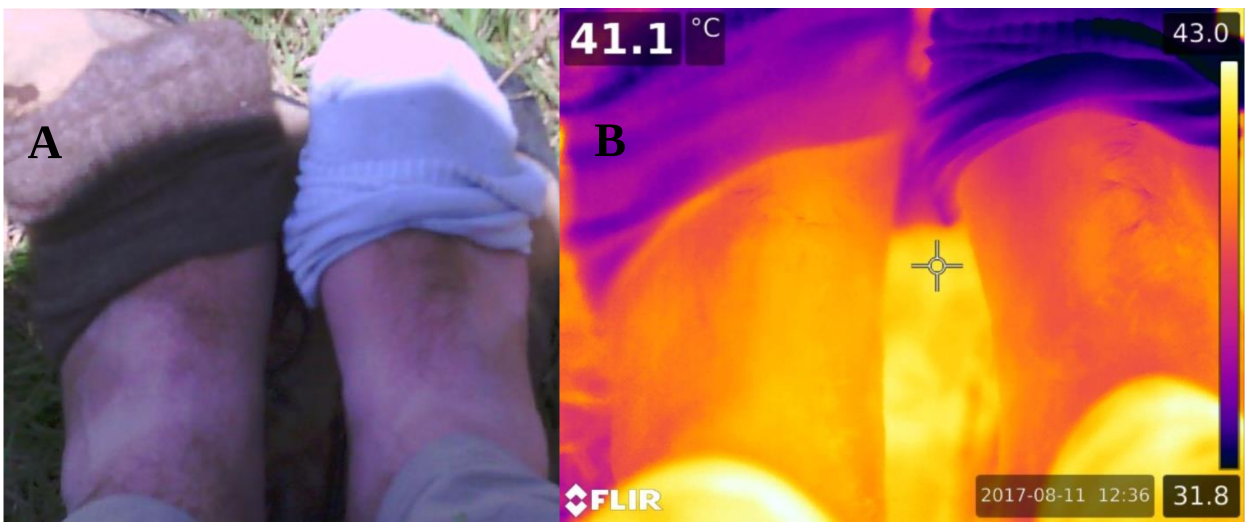

Figure 5. Side by side comparison. Left image (A) is visible spectrum photo, right photo (B) is longwave infrared thermal image. Within each image (A & B): temperatures of each foot; left foot had the wool sock (99.6 ± 1.0°F (37.5 ± 0.6°C), ε = 0.99); whereas the right foot had the Hanes cotton sock (98.2 ± 0.7°F (36.8 ± 0.4°C), ε = 0.99).