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Is Shade Needed For Livestock in the Eastern U.S.?

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North Carolina State University, Raleigh, NC

And

Kevin Ogles
USDA NRCS ENTSC Grazing Lands Specialist

March 29, 2017 Webinar

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Is Shade Needed For Livestock in the Eastern U.S.?

- To Answer This Question We Need to Ask Other Questions:
- How Should We Currently Determine the Need for Shade?
- What Models Are Available for Livestock Producers to Use to Determine the Need for Shade?
- What Can We Learn From Observation in the Absence of Scientific Data?

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To Understand the Need for Shade We Must Know about Livestock Heat Stress

- Few Scientific Trials of All Livestock Species on Pasture with Published Results – Dr. Mark McCann, UGA
- Little Information on Livestock Species besides Cattle
- More Scientific Data on Confined Dairy and Feedlot Beef than These on Pasture

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Livestock Heat Stress Terms

- What is the Thermonuetral Zone of Livestock Species?
- What does that mean in relation to shade?

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Thermoneutral Zone of Livestock

NRCS NRPH Definition - When the animal is in the thermoneutral zone (TNZ) no physiological processes are activated that require the expenditure of a considerable amount of energy to maintain normal body temperature. In the TNZ, body temperature is physiologically regulated by the constriction or dilation of the peripheral blood vessels and by some sweating. Little energy is required by these processes, and intake is not affected when temperatures are in the animal's TNZ.

Inconsistent Data - U.S. and Europe Information based on air temperature and humidity only

- Beef Cattle data shows both 45°F to 74°F and 32°F to 77°F
- For Dairy Cattle 41°F to 68°F
- Sheep 70°F to 88°F or 10°F to 90°F
- Goats 50°F to 68°F or 32°F to 86°F
- Horses 41°F to 77°F

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Temperature Humidity Index

- Cattle shed heat
  - primarily through evaporation from the skin and through respiration (breathing)
  - The higher the humidity and the less amount of wind (speed) the harder for the animal to get rid of the heat.
- Delivered Heat Stress in Livestock is a combination of Many factors
- The Wiersama model for the Temperature Humidity Index (also called the Thermal Heat Index) is a Dairy Cattle Stress Index tool that uses Temperature and Humidity (but leaves out wind speed, solar radiation and other factors!)
- Anything at 71 THI or below is in the TNZ (until freezing condition weather)

TEMP °F	RELATIVE HUMIDITY																			
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
72																				72	72
73																		72	72	73	73
74																72	72	73	73	74	74
75														72	72	73	73	74	74	75	75
76												72	72	73	73	74	74	75	75	76	76
77											72	73	73	74	74	74	75	75	76	76	77
78										72	73	73	74	74	75	75	76	76	77	77	78
79									72	73	73	74	74	75	76	76	77	77	78	78	79
80							72	72	73	73	74	74	75	76	76	77	78	78	79	79	80
81						72	72	72	73	74	75	75	76	77	77	78	78	79	80	80	81
82						72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82
83					72	73	73	74	74	75	76	77	78	78	79	80	80	81	82	82	83
84				72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83	83	84
85			72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84	85
86			72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	86
87		72	73	73	74	75	76	77	77	79	79	80	81	81	82	83	84	85	85	86	87
88	72	72	73	74	75	75	76	77	78	79	80	81	81	82	83	84	85	86	86	87	88
89	72	73	74	75	76	76	77	78	79	80	80	81	82	83	84	85	86	87	87	88	89
90	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	87	88	88	89	90
91	73	74	75	76	76	77	79	79	80	81	82	83	84	85	86	87	88	89	89	90	91
92	73	74	75	76	77	78	79	80	80	82	83	84	85	85	87	88	89	90	90	91	92
93	74	75	76	77	78	79	80	80	81	83	83	84	85	86	88	89	90	91	91	92	93
94	74	75	76	77	78	79	80	81	82	83	84	85	86	87	89	90	91	92	92	93	94
95	75	76	77	78	79	80	81	82	83	84	85	86	87	88	90	91	92	93	93	94	95
96	75	76	77	78	79	80	81	82	83	85	85	87	88	89	91	92	93	94	94	95	96
97	76	77	78	79	80	81	82	83	84	85	86	87	88	89	91	93	94	95	95	96	97
98	76	77	78	79	80	82	83	84	84	86	87	88	89	90	92	94	95	96	96	97	98
99	76	78	79	80	81	82	83	84	85	87	88	89	90	91	93	95	96	97	97	98	99
100	77	78	79	80	82	83	84	85	86	87	88	90	91	92	94	96	97	97	98	99	
101	77	79	80	81	82	83	85	86	87	88	89	90	92	93	95	97	98	98	99		
102	78	79	80	81	83	86	85	86	87	89	90	91	92	94	96	98	99	99			
103	78	80	81	82	83	86	86	87	88	89	91	92	94	95	97	99					
104	79	80	81	82	84	85	86	88	89	90	91	93	94	95	98						
105	79	81	82	83	84	85	87	88	89	91	92	94	95	96				equals	TNZ		
106	80	81	82	86	85	86	88	89	90	92	93	94	95	97							
107	80	81	83	86	85	87	88	89	91	92	94	95	96	98				equals	MILD STRESS		
108	81	82	83	85	86	87	89	90	92	93	94	96	97	99							
109	81	82	86	85	87	88	89	91	92	94	95	96	98					equals	MODERATE STRESS		
110	81	83	86	86	87	88	90	91	93	94	96	97									
111	82	83	85	86	88	89	91	93	94	95	96	98						equals	SEVERE STRESS		
112	82	86	85	87	88	90	91	94	94	96	97										
113	83	86	86	87	89	90	92	95	95	96	98							equals	FATAL		
114	83	85	86	88	89	91	92	94	96	97											
115	86	85	87	88	90	91	94	95	96	98											
116	86	86	87	89	90	92	94	95	97												
117	85	86	88	89	91	93	94	96	98												
118	85	87	88	90	92	93	95	97													
119	85	87	89	90	92	94	96	97													
120	86	88	89	91	93	94	96	98													
121	86	88	90	92	93	95	97														

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Temperature Humidity Index for Dairy Cattle

- THI of 72 through 79 is Mild Stress – H2O intake slight+
- THI of 80 through 89 is Moderate Stress on the animals. Management actions should be taken to help the livestock relieve the heat, such as shade and providing lots of fresh water.
- A THI of 90 or More puts the livestock under Severe Stress and all measures should be taken to cool them. Besides providing water and shade, use misters, mister fans, or other measures. A few percentage points (increase) change in RH at this level and the heat could be fatal to them. I could not find records of this happening in the East Region.

The ideal temperature range for beef cattle is between 41°F and 77°F. When temperatures exceed this, cattle are at risk of heat stress. Many environmental factors affect the potential for heat stress, including relative humidity, wind speed, solar radiation, ground cover, access to water, diet, shade and nighttime temperatures. In addition, individual animal characteristics can contribute to heat stress. These include hide color, breed, health, adaptation, hair coat length and disposition. When a combination of these factors and ambient temperature cause an animal's heat load to exceed its ability to dissipate that heat, heat stress occurs.

- Dr. Deke Alkire, Samuel Roberts Noble Foundation

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Livestock Weather Hazard Guide

Relative Humidity (%)

Dry Bulb Temp. (F)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
75									70	70	71	71	72	72	73	73	74	74	75	75
76							70	70	70	71	72	72	72	73	74	74	74	75	76	76
77						70	70	71	71	72	72	73	73	74	74	75	75	76	76	77
78					70	70	71	71	72	72	73	74	74	75	75	76	76	77	78	78
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80			70	70	71	72	72	73	73	74	74	75	76	76	77	78	78	79	79	80
81		70	70	71	71	72	73	73	74	75	75	76	77	77	78	78	79	80	80	81
82		70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82
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86	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	86
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89	73	74	74	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87	88	89
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91	74	75	76	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89	90	91
92	74	75	76	77	78	79	80	81	82	83	84	84	85	86	87	88	89	90		
93	75	76	77	78	79	80	80	81	82	83	84	85	87	87	88	89	90			
94	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90				
95	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90					
96	76	77	78	79	80	81	82	84	84	86	87	88	89	90	91					
97	77	78	79	80	81	82	83	84	85	86	87	88	90	91						
98	77	78	79	80	82	83	84	85	86	87	88	89	90							
99	78	79	80	81	82	83	84	86	87	88	88	90								
100	78	79	80	82	83	84	85	86	87	88	90	91								
105	80	82	83	84	86	87	89	90	91											

Alert
Danger
Emergency

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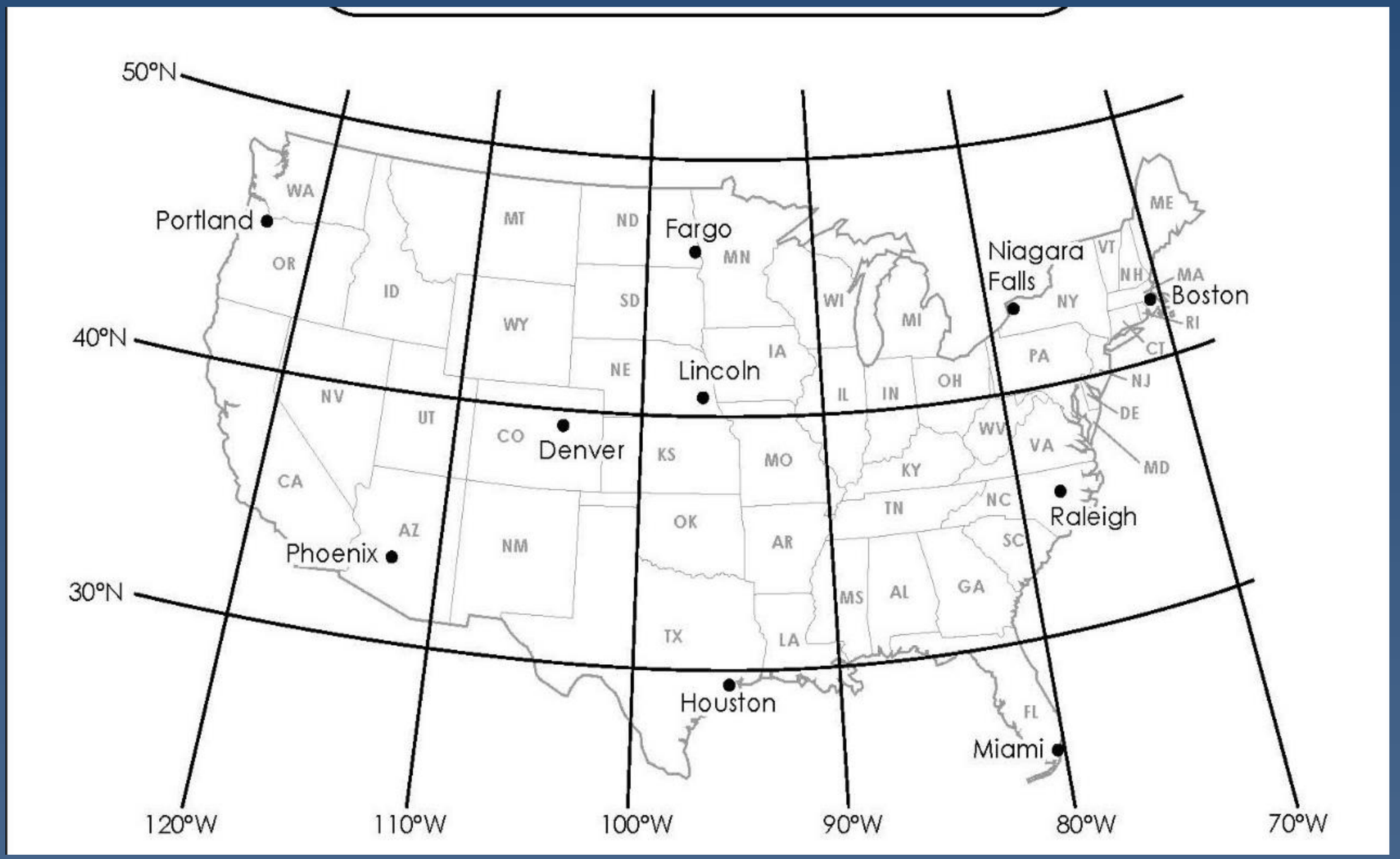

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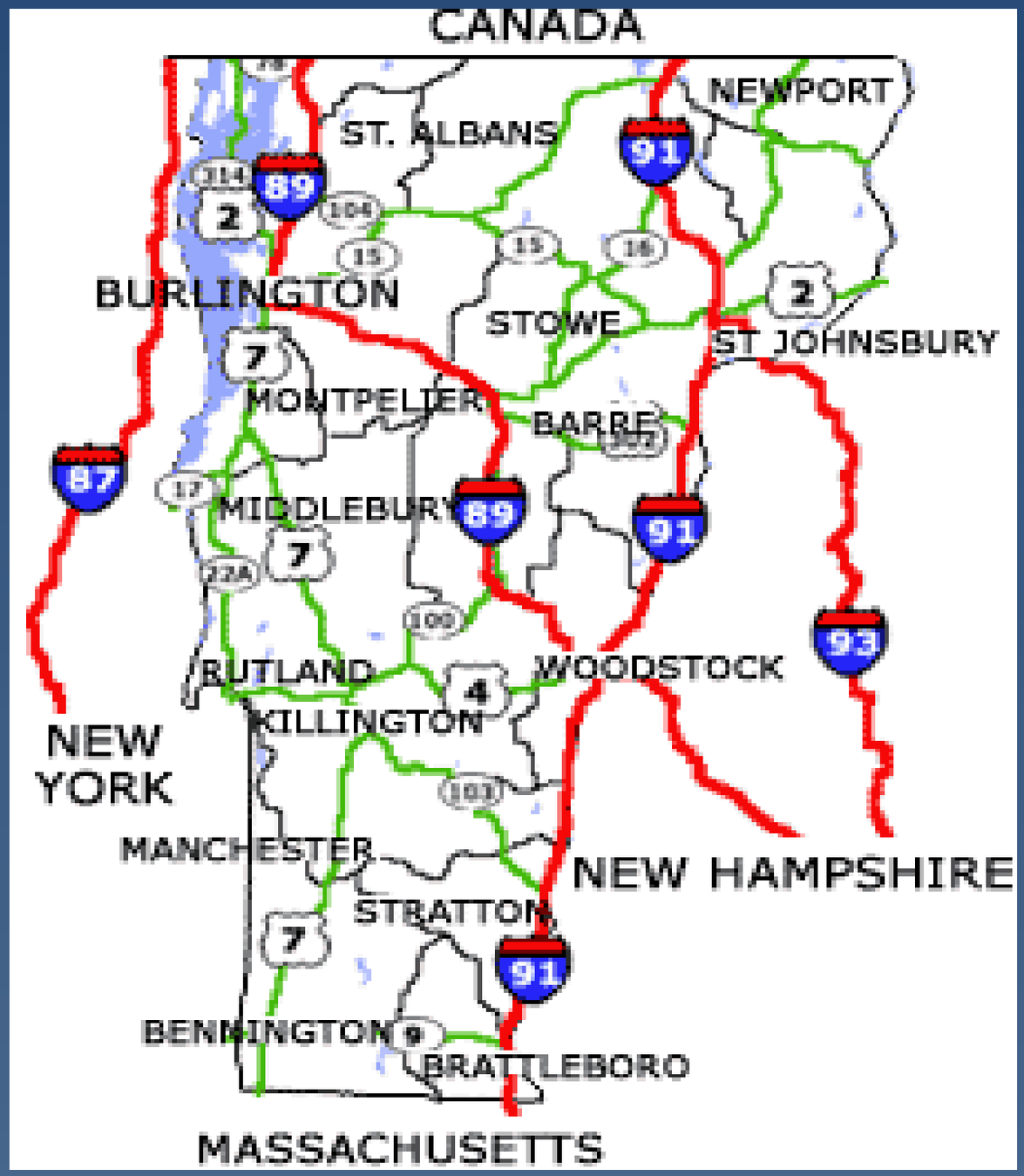

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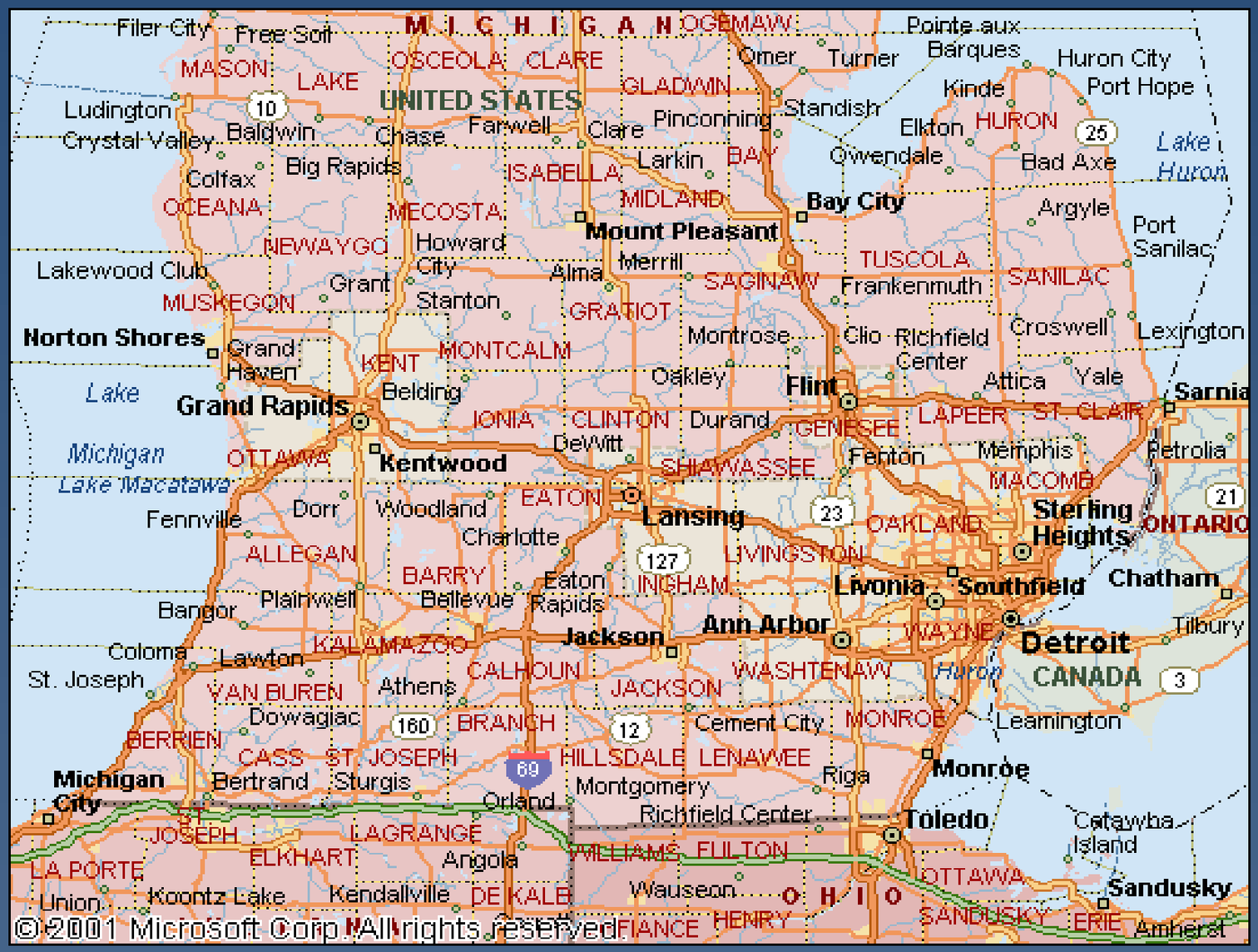

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U.S. Avg. Weather Data from NOAA Records in Avg Max Temp in ºF and PM %RH							
Location	**Avg Max June**	**RH**	**Avg Max July**	**RH**	**Avg Max Aug**	**RH**	**Lat.**
Burlington, VT	78.1	53	83.2	56	83.5	60	**44**
Detroit, MI	79.3	54	83.4	57	81.4	57	**42**
Harrisburg, PA	81.2	52	85.3	55	83.5	56	**40**
WDC Dulles, VA	83.8	63	87.9	63	86.6	63	**39**
Raleigh, NC	87.1	58	90.2	59	88.4	59	**36**
Goldsboro, NC	87.6	58	90	59	88.3	59	**35**
Montgomery, AL	89.1	48	91.8	53	91.3	53	**32**
Beckley, WV	77	63	79.8	63	79.2	63	**38**
Asheville, NC	81.3	62	84	62	82.9	62	**35**

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Temperature-Humidity Index based on Monthly Averages from 30-50 years of NCC weather data

	Central and Western UP	Eastern UP	Northern Lower	Central Lower	Southern Lower
June	67.6	67.6	71	73.5	74
July	74	72.4	75.5	77	76.4
August	70	71	72.9	74.5	75

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Windchill Chart in °F

Actual Temp	MPH ↓	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
Equiv. Temp	Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	5	48	37	27	16	6	5	-15	-26	-35	-47	-57	-68
	10	40	28	16	3	-9	-22	-34	-46	-58	-71	-83	-95
	15	36	22	9	-5	-18	-31	-45	-58	-72	-85	-99	112
	20	32	18	4	-10	-24	-39	-53	-67	-81	-95	110	129
	25	30	16	1	-15	-29	-44	-59	-74	-88	-103	118	133
	30	28	13	-2	-18	-33	-49	-64	-79	-93	-109	125	140
	35	27	11	-4	-20	-35	-52	-67	-82	-97	-113	129	145
	40	26	10	-5	-21	-37	-53	-69	-84	-100	-115	132	148
	45	25	9	-6	-22	-38	-54	-70	-85	-102	-117	135	150

Average Number of Days with an Average Maximum Temperature of 90°F or More (+ avg. THI score) and Average Wind Speed

Max. Temps mostly occur in July; Wind in July-Aug.	Central and Western UP	Eastern UP	Northern Lower	Central Lower	Southern Lower
Hot Days	4 THI=74	2 THI=72	4 THI=75	6 THI=77	9 THI=76
Wind	No data available	7.7 – 8.5	7.0 – 7.8	6.7 – 7.5	7.5 – 8.8

What about the Specific Details of Michigan's Average 'Hot' period of the Summer?

Mid June	West, Central and East UP - None	Northern Lower - None	Central Lower - None	Southern Lower – 3 times Mild
July 1st	None	1 time Mild Stress	None	4 times Mild Stress, 1 Moderate
July 15th	None	2 times Mild Stress	2 times Mild Stress	2 times Mild Stress, 2 Moderate
August 1st	None	3 times Mild and 1 time Moderate	1 time Mild Stress	3 Mild and 3 Moderate
August 15th	1 time Mild Stress	2 times Mild Stress	2 times Mild Stress	2 Mild, 1 Moderate

From 4 to 7 years of "Free" MAWN data with wind effect conservatively adjusted THI

Table 5.1 Daily water intake of dairy heifers under various temperature conditions.

Air temp. (degrees F)	lb water/ lb TDN	lb TDN/ day	gal water/ day
35	4.7	10.3	5.8
50	5.2	9.2	5.7
70	7.2	9.2	7.9
80	9.0	8.8	9.5
90	22.2	6.6	17.6
95	24.8	6.4	19.0

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"Our results indicate that providing cattle with water troughs away from riparian zones tended to reduced the amount of time cattle spent in riparian zones by 63% (52 min/day) when environmental conditions were not stressful (THI <72). When environmental conditions became stressful (THI >72), our data indicate that cattle spent similar amounts of time in riparian zones whether or not troughs were available."

Impact of water troughs on cattle use of riparian zones in the Georgia Piedmont in the United States (Cabrera, et. Al. 2009)

NOAA Records	J, Ju, A, 2016 Data				Monthly	Monthly	
Location	Avg. W	90°F+d	CL-3	H-CL Days	(W) THI	(N) THI	Lat.
Burlington, VT	7.3	10	136	16	76 - Mi	75 - A	44
Detroit, MI	7.1	21	32	26	75 - Mi	75 - A	42
Harrisburg, PA	5.6	11	62	22	76 - Mi	77 - A	40
WDC Dulles, VA	6.1	45	59	22	81 - Mo	81 - D	39
Raleigh, NC	5.3	58	16?	22	81 - Mo	81 - D	36
Goldsboro, NC *B	6	42	454+	21	81 - Mo	82 - D	35
Montgomery, AL *A	4.6	86	444+	22	83 - Mo	82 - D	32
Beckley, WV	5.3	1	309+	10	74 - Mi	74 - TNZ	38
Asheville, NC	4.6	18	351+	16	77 - Mi	78 - A	35

*A mid 80 range for 60+ days at Moderate, close to (N) Emergency

*B Highest RH in August avg. 95% (M) to low mid-day of 53%

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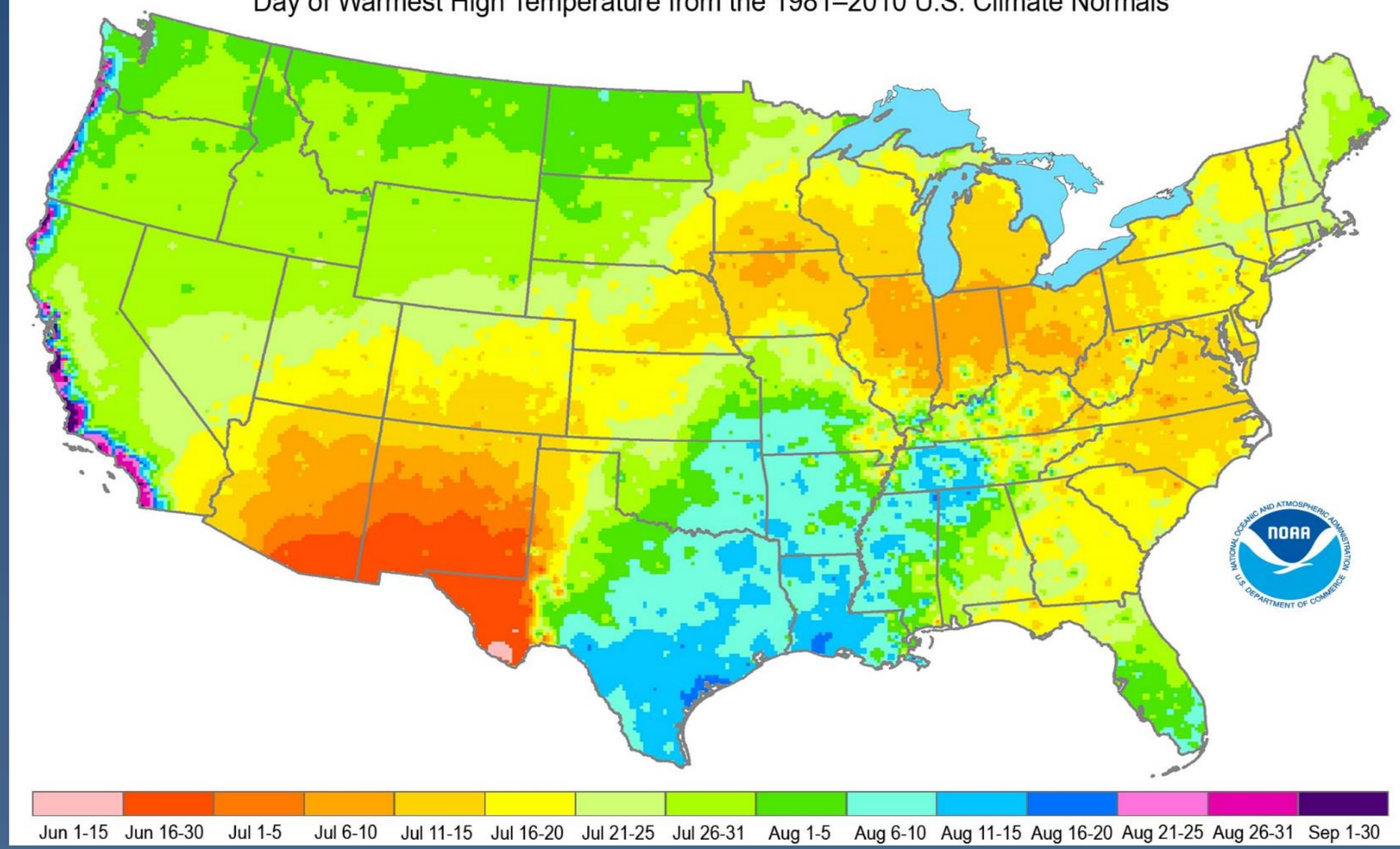
Warmest Day of the Year

Day of Warmest High Temperature from the 1981–2010 U.S. Climate Normals



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AEN-99

Shade Options for Grazing Cattle

Stephen F. Higgins, Carmen T. Agouridis, and Sarah J. Wightman, Department of Biosystems and Agricultural Engineering

Shade is a must for pasture-based grazing systems. It curtails heat stress, which is detrimental to cattle and causes a decrease in milk production, feed intake, weight gains, and fertility.

Heat stress is made worse in Kentucky and other humid parts of the eastern United States by the endophytic fungi that infect tall fescue, which is one of the most widely grown pasture grasses in the region. It's estimated that up to 95% of tall fescue pastures are infected with endophytes. Cattle grazing endophyte-infected pastures experience increased body temperatures, largely from their inability to effectively transfer heat from their skin by sweating.

Heat Stress in Cattle

For dairy and beef cattle, the ideal ambient temperature is between 41° and 77° F. When temperatures are over 77° F, cattle may begin to experience heat stress depending on a number of environmental factors, including relative humidity, solar radiation, wind speed, access to water, and diet. Other factors, such as the amount of vegetation present, can also impact heat stress. Dry lots with limited to no vegetation will reflect more light and heat than thick grass pastures, as will graveled and concrete areas. Controlling the amount of solar radiation that cattle receive is one of the best methods of reducing heat stress.

Heat stress can vary with cattle characteristics. Cattle with dark coats experience higher body temperatures than those with light ones. For the genotype *Bos Taurus*, the inward flow of heat was 28% greater for cattle with dark red coats as compared to those with white coats. Heavy cattle are more susceptible to heat stress than lighter cattle because of the increased fat deposits. The increased metabolic heat produced by lactating cattle also makes them more susceptible to heat stress. Sick or stressed cattle are also more affected by heat stress than healthy cattle.

Signs of heat stress, such as increased water intake or reduced feed intake, may be subtle and therefore difficult to recognize. Other signs, such as increased respiration rate (greater than 90 breaths per minute), standing versus lying down, and congregating under shade or at water sources are more easily identified. As both temperature and humidity play a significant role in heat stress, looking at the combined impact of these factors can help identify potentially dangerous conditions for cattle. Figure 1 shows the various temperature and humidity combinations that result in low to high heat stress.

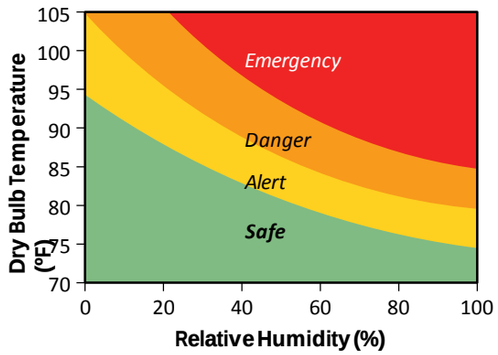


Figure 1. Livestock Heat Stress Guide. Adapted from the Livestock Weather Hazard Guide, Samuel Roberts Noble Foundation, Inc.

Benefits of Shade

Although animals tend to reduce feed intake when they congregate under shade, there are benefits to shade in pasture-based grazing systems, which are explained in this publication.

Although the benefits of providing shade to cattle will vary depending on factors such as breed, coat color, weight, health, and lactation status, producers may be able to increase production and improve pasture use and water quality by providing it.

Weight Gain

Research at the University of Kentucky's Animal Research Center indicated that beef cows and calves showed improved weight gain with the use of portable shade during the heat stress periods of spring and early summer. An increase of 1.25 lb per day for cows, 0.41 lb per day for calves, and 0.89 lb per day for steers was achieved when shade was provided. Research at the University of Missouri found that providing shade had the biggest effect on cattle grazing endophyte-infected pastures. Those cattle gained 0.72 lb per day more than cattle without shade. At the University of Arkansas, researchers found that providing cattle with artificial shade resulted in an average daily gain of more than 20% compared to cattle with no shade, and cattle with tree shade showed nearly a 60%increase compared to those with no shade.

This publication is dedicated to the memory of Larry W. Turner, Ph.D., whose work helped make it possible. Some of the ideas and designs in this publication are based on his work as a specialist.

AS1615

Dealing With Heat Stress in Beef Cattle Operations

C.R. Dahlen, Beef Cattle Specialist
C.L. Stoltenow, Veterinarian

Being proactive is the best approach for dealing with heat stress in cattle. Once cattle are in a severe state of heat stress, you may be too late to help them. Interventions that cause animals to cool extremely rapid or animal distress could have disastrous consequences. Having a solid management plan in place to address heat stress could pay big dividends in the form of maintained animal performance during periods of heat and in avoiding death losses in severe cases.

NDSU EXTENSION SERVICE
North Dakota State University
Fargo, North Dakota

JULY 2012

Introduction to Thermoregulation

Mammals have involuntary methods of regulating internal body temperature. They include shivering and sweating to maintain "homeostasis," or a constant, stable environment. Homeostasis is good, and, as cattle managers, we regularly use it to our benefit. Using a thermometer to determine if a calf has a fever is only possible because of homeostasis.

The thermoneutral zone is the range of temperatures in which an animal (including humans) does not use energy to stay warm or stay cool. When temperatures rise above the thermoneutral zone, animals must expend energy to cool their bodies. Signs this is occurring include an increasing respiration rate, increased heart rate and increased panting. At the same time the animals use extra energy, their feed intake declines.

Heat stress occurs when the animal's attempt to dissipate heat is unsuccessful or overwhelmed, and the animal's performance or health suffers as a result.

Managing Heat Stress

Step one:

Identify animals that are most susceptible to heat stress.

Feedlot animals that are closest to the market endpoint are the most at risk. They are physiologically overweight and have the least amount of lung capacity relative to body weight.

Animals that are very young and very old also are at increased risk. They do not have the physiologic reserves to withstand prolonged periods of heat.

Related Topics

Forecast Maps

- Continental US

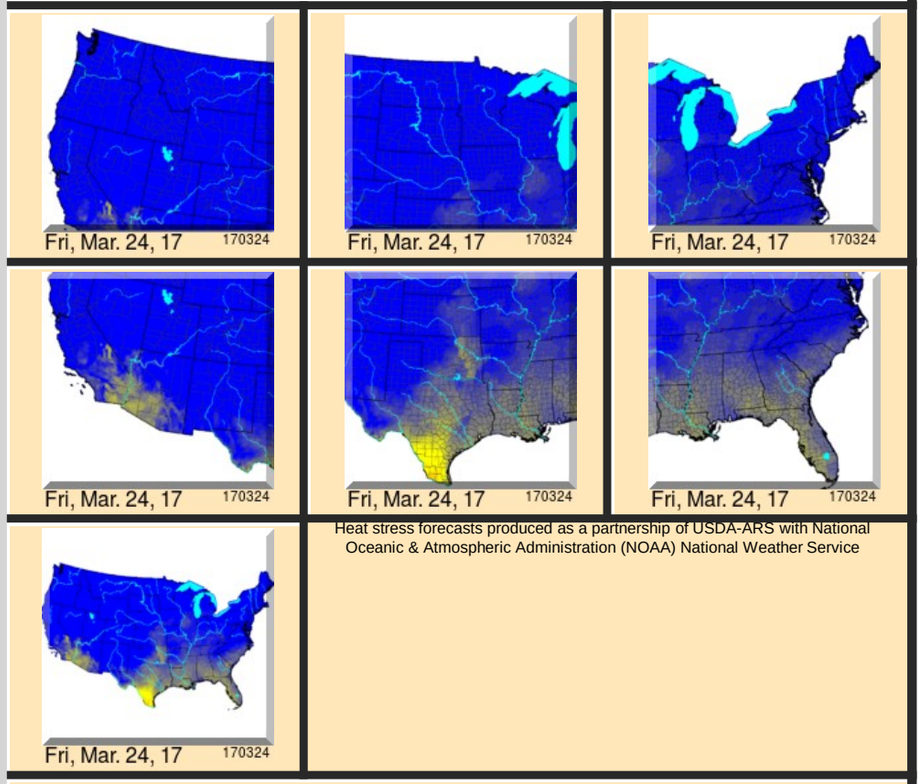
About Cattle Heat Stress

- Forecasting Heat Stress
- Impact Of Heat Stress
- Cattle Risk Factors
- Environmental Risk Factors
- Recognizing Heat Stress
- Actions To Minimize Heat Stress
- Disclaimer

Cattle Heat Stress Forecast

Forecast Originated on Friday, Mar. 24, 2017

Click on a region for the 7 day forecast.



Acknowledgements:

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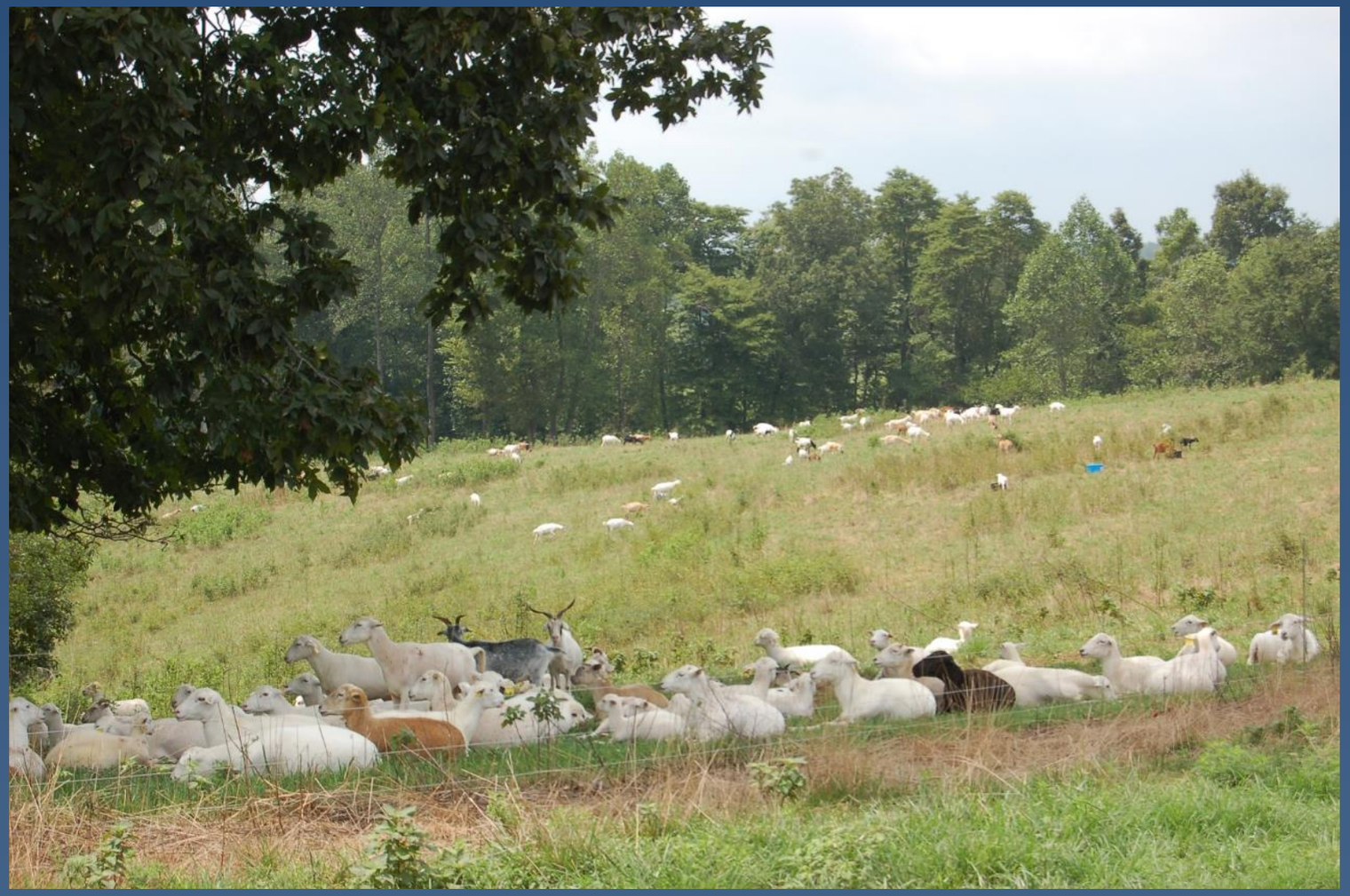

Experiences with Shade in the Southeastern US

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Pasture-Based Livestock Education Program

NC State University A&T State University COOPERATIVE EXTENSION

Empowering People · Providing Solutions

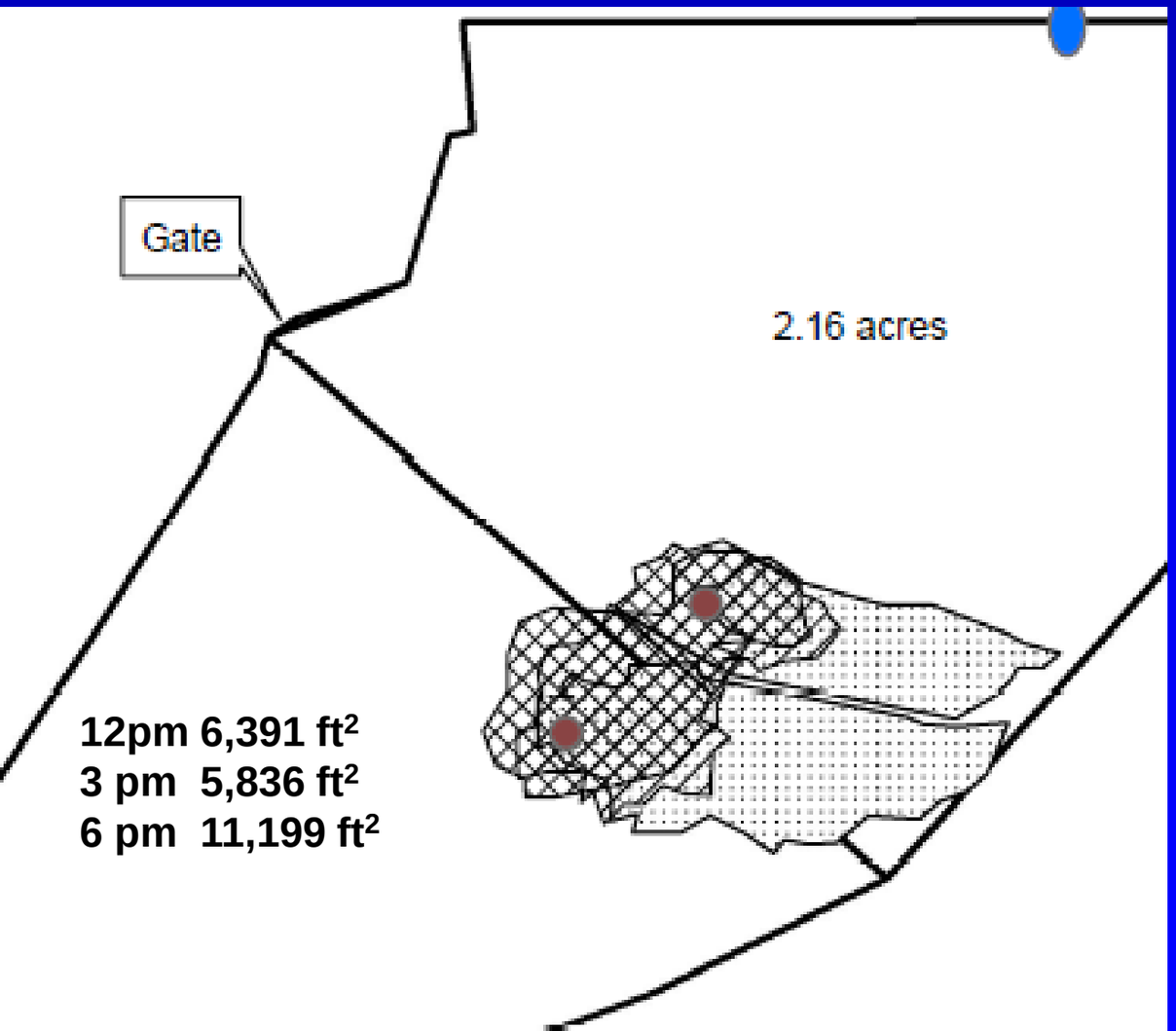
Is Shade Needed for Cattle in the Southern US?

- Production demand – Dairy vs Beef?
- High temps? Commonly over 100 heat index?
- Toxic Fescue in forage system?
- Cattle Genetics? Heat tolerant or European breeds?
- Access to surface water?
- Acclimation of cattle.
  - Short-term
  - Long-term

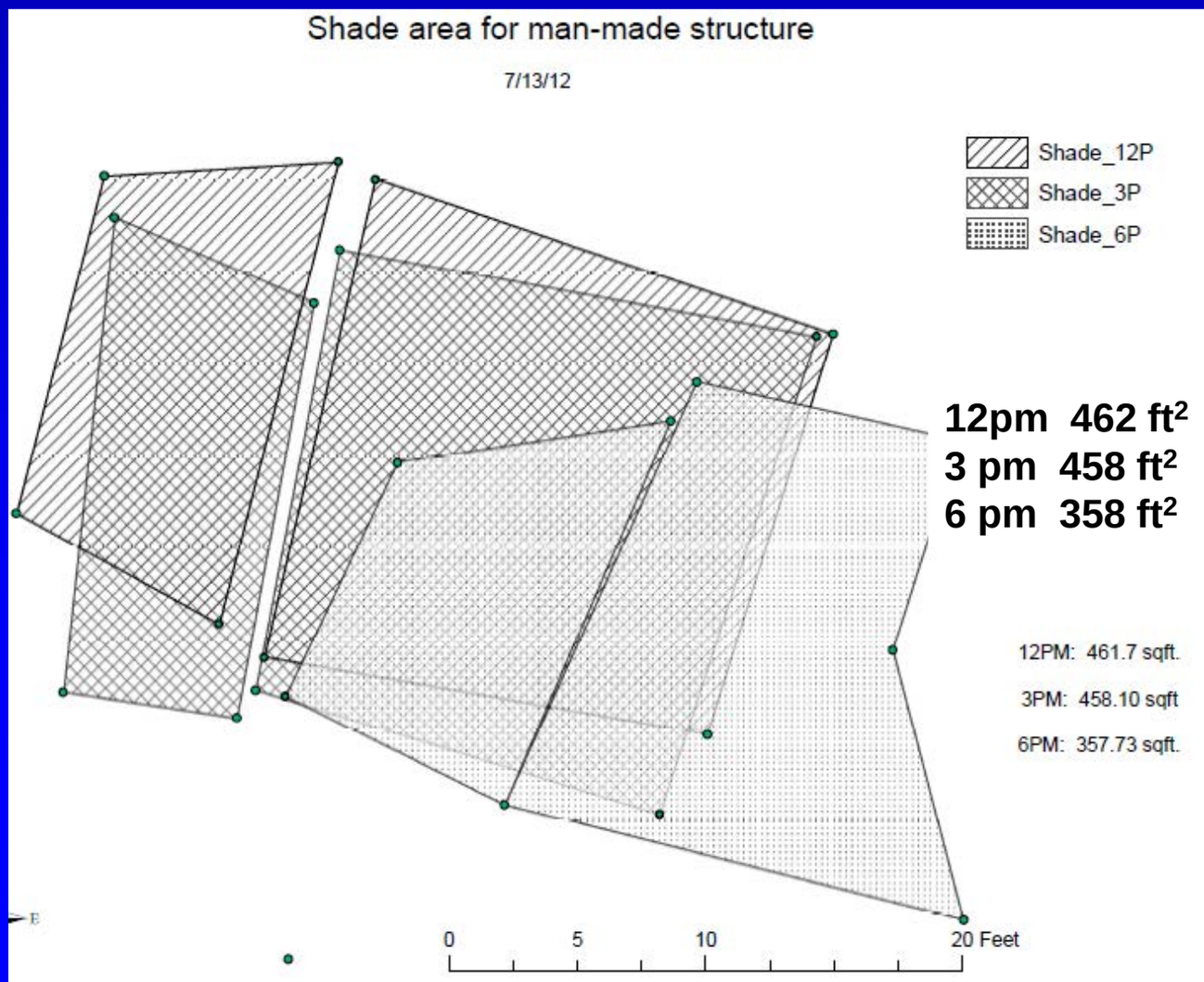
Shade Management Considerations

- Cattle on toxic tall fescue should always have access to shade during summer?
- Other systems, shade in all paddocks or none.
- In no-shade systems a “shade paddock” or other emergency escape is critical (>100°F HI?).
- Night time grazing/daytime shade works well
- Constructed vs natural shade
- When possible use old fence rows as shade lines when laying out pasture
- Placing shade away from riparian areas can reduce impact on surface water

Natural vs. Constructed Shade



12pm 6,391 ft²
3 pm 5,836 ft²
6 pm 11,199 ft²



12pm 462 ft²
3 pm 458 ft²
6 pm 358 ft²


Legend
Shade12P
Shade3P
Shade6P

Should We Be Using Tropically Adapted Cattle?

Influence of Angus phenotype on body temperature during summer

Ona White Angus

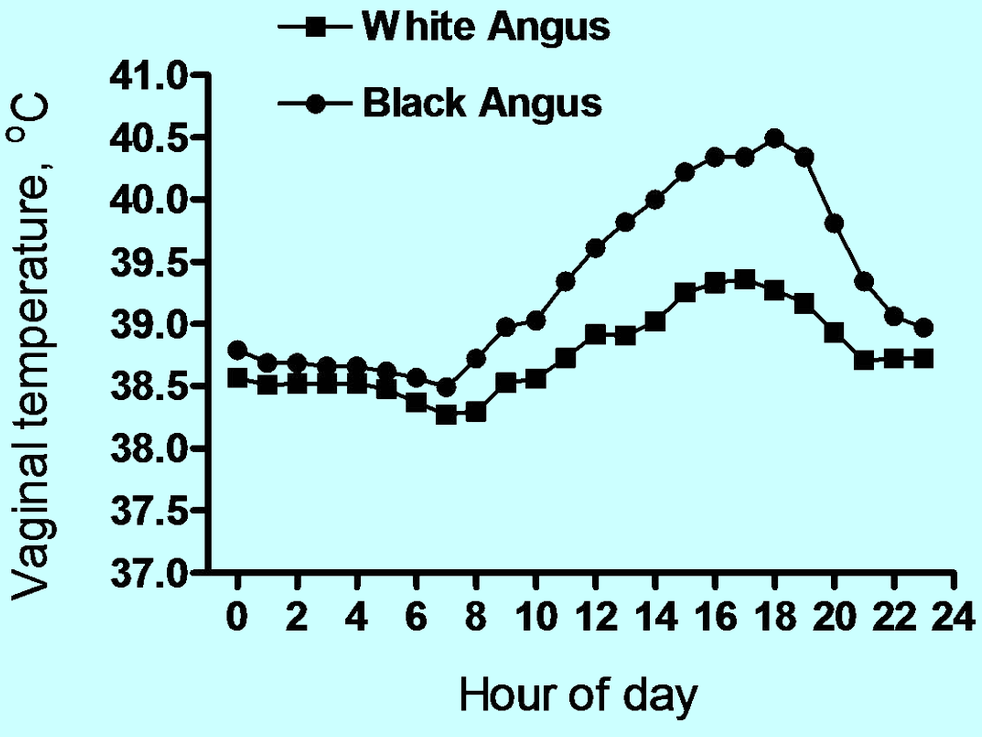


Figure 2. Influence of hair coat color on vaginal temperature of pre-weaned Angus heifer calves.

Slick Hair Trait

- Mapped to Chromosome 20 (Mariasegaram et al, 2007)
- Found in predominantly Bos Taurus indigenous breeds of the Americas
- Imparts “tropically adapted” phenotype seen in Senepol Cattle
- Dominant trait (Olson et al. 2003)?
- Appears to be more complicated than originally thought (Huson et al, 2014)
- Opportunity to introduce heat tolerance into breeds with high meat quality
- Senepol outperformed Angus in a Costal Plain NC no-shade system (at CEFS)

Slick Hair

1/8 Senepol, 1/4 Gelbvieh, 5/8 Angus flushmates

Normal Hair

Slick Hair

1/8 Senepol, 1/4 Gelbvieh, 5/8 Angus flushmates

Normal Hair

Summary

- Shade is an important consideration for animal performance and welfare
- Shade is critical in systems with toxic fescue
- All systems will benefit from an emergency shade plan
- Improved heat tolerance in cattle would reduce dependence on shade.

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USDA NRCS

Is Shade Needed For Livestock in the Eastern U.S.?

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