Comfort and Performance: Maximizing Both

AJ Tarpoff & Lily Edwards-Callaway

What is the goal?

- Everything has to go right
- Consistent high marbling isn’t an accident
- **Husbandry**, Genetics, Nutrition

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Animal welfare

Image modified by WAZA from Mellor and Beausoleil 2015

1. Freedom from hunger and thirst
by ready access to fresh water and diet to maintain health and vigor

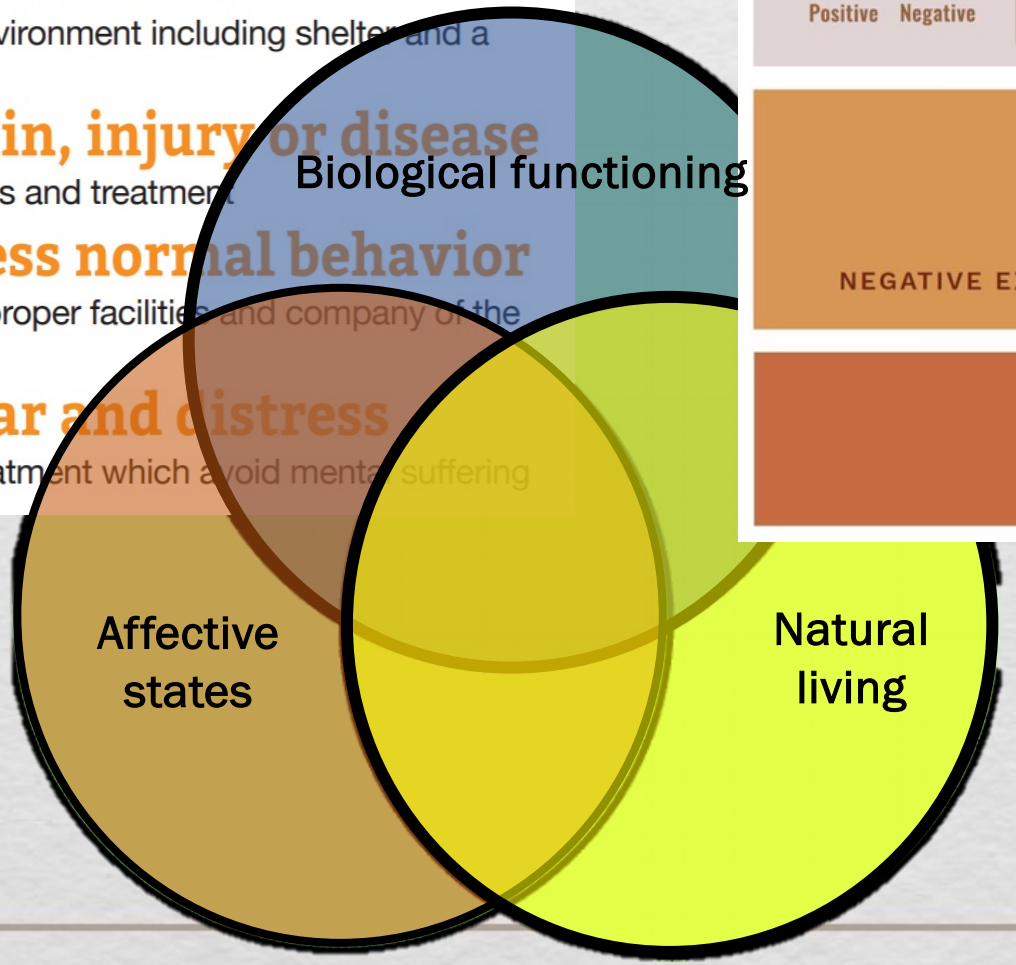
2. Freedom from discomfort
by providing an appropriate environment including shelter and a comfortable resting area

3. Freedom from pain, injury or disease
by prevention or rapid diagnosis and treatment

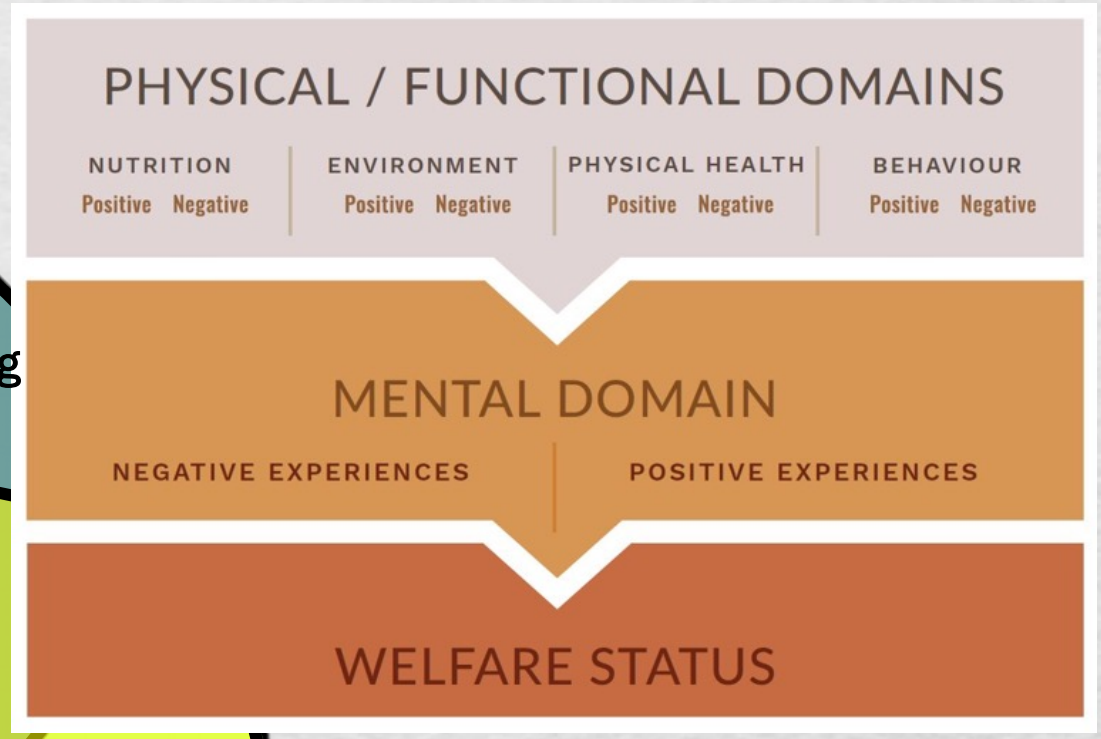
4. Freedom to express normal behavior
by providing sufficient space, proper facilities and company of the animal's own kind

5. Freedom from fear and distress
by ensuring conditions and treatment which avoid mental suffering

(FAWC, 1979)



(Fraser et al., 1997)



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How do you maximize cattle comfort?

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What do consumers think about animal welfare?

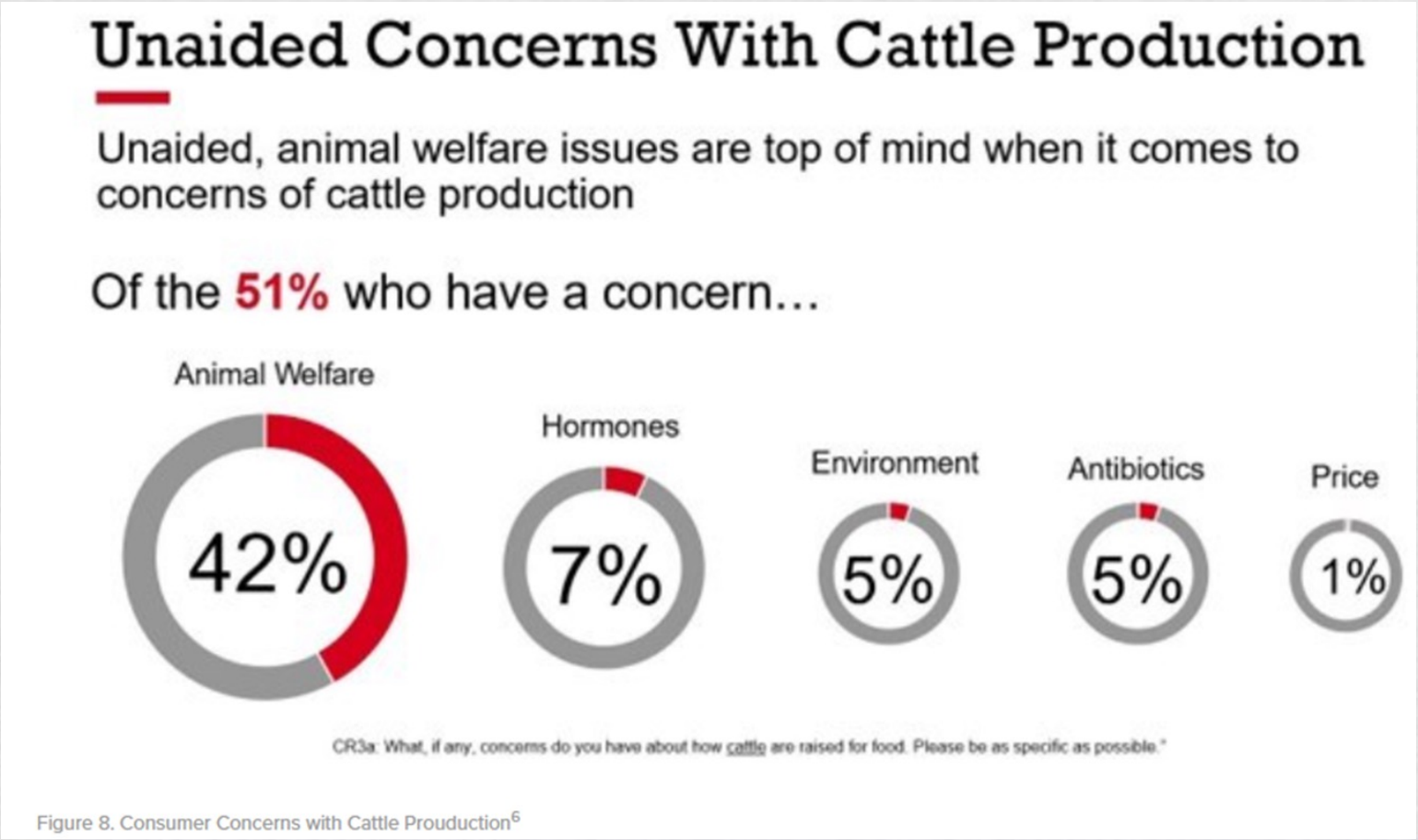

Figure 8. Consumer Concerns with Cattle Prouduction[6]

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How differences in frames of reference change assessments of animal welfare

II. Ability to engage in natural behaviour (green)
Daylight (1)
Natural growth rate (2)
Natural behaviour (3)
Body care (4)
Natural environment (5)
Explorative behaviour (6)
Social behaviour (7)
Natural birth (8)
Maternal behaviour (9)
Sexual behaviour (10)
Having fun (11)
Foraging behaviour (12)
Play behaviour (13)
Genetic selection (14)

(Vanhonakcer et al., 2008)

- Differences between farmers' and citizens' *perceived importance* of various welfare attributes
- Ability to engage in natural behavior showed the biggest gap between interest groups

One area that impacts cattle performance & comfort.....

Protecting livestock from heat stress as temperatures rise

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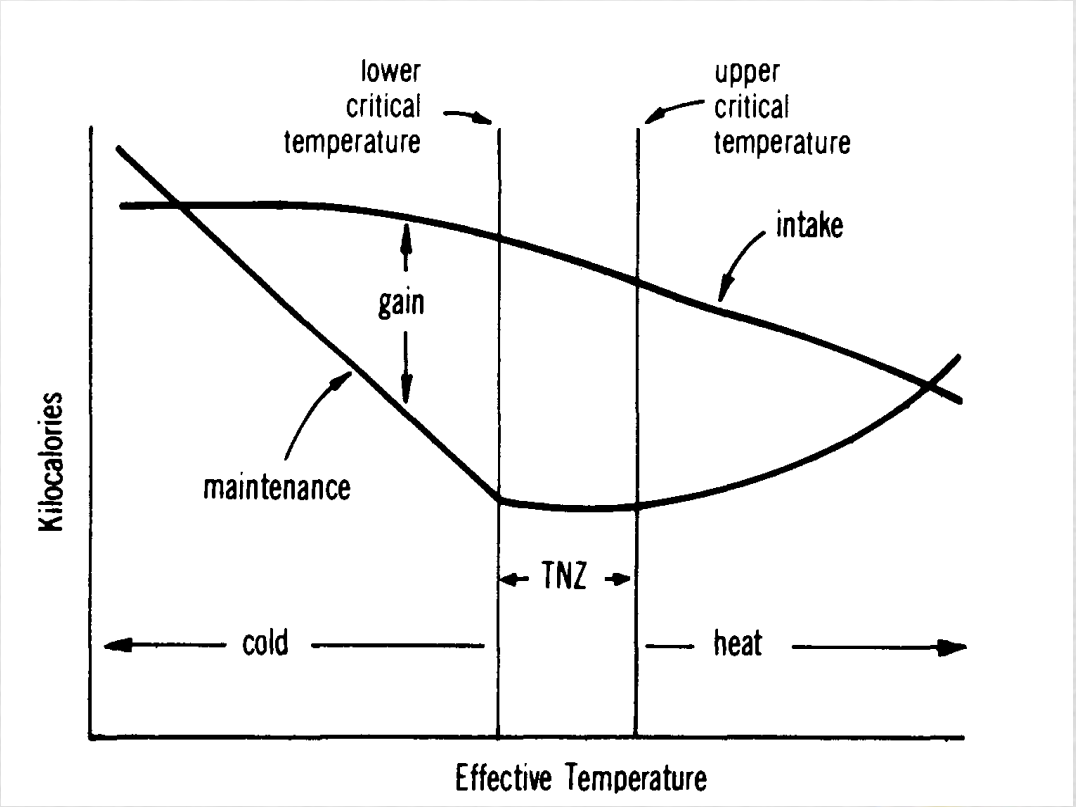
Thermoneutral Zone (TNZ)

- Environment where the animal achieves maximal comfort and performance

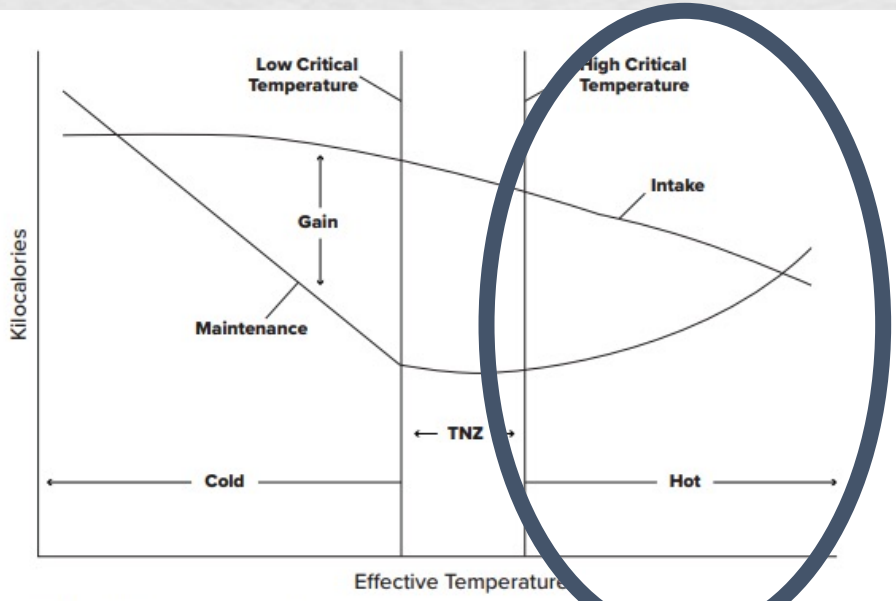


Ames, 1980

Cattle Care Outside TNZ

- Steps taken to minimize environmental impacts
- Often seen as an added cost
- Or is it an investment in the animal to reach its genetic potential?

Environmental Stress- Hot



Effective of temperature on rate of feed intake, maintenance energy requirement, and gain
Source: Ames (1980)

[1] *Bond, T.E., W.N. Garrett, R.L. Givens and S.R. Morrison. 1970. Comparative effects of mud, wind and rain on beef cattle performance. Paper No. 70-406. Annu. Meeting A.S.A.E.*

- ~$369 Million/year in losses to the Beef Industry
  (St. Pierre et al 2003 study)
- Decrease Intake
- Increase Maintenance
- Potential for Mortality
- Decreased Fertility

Animal Responses to Heat Stress

- Physiologic response
  - ↑ body temperature
  - ↑ respiration rate
  - ↑ panting
  - ↑ sweating (minimal)
- Behavioral response
  - ↓ DMI
  - ↑ standing
  - ↑ water intake
  - ↑shade seeking

Robertshaw, 2006; Bernabucci et al., 2010; Edwards-Calloway et al., 2021

Factors of Heat Stress

- Temperature
- Humidity
- **Wind speed**
- **Solar radiation (cloud cover)**
- **Cumulative Heat Load**
  - Accumulate heat during day
  - Dissipate at night*****

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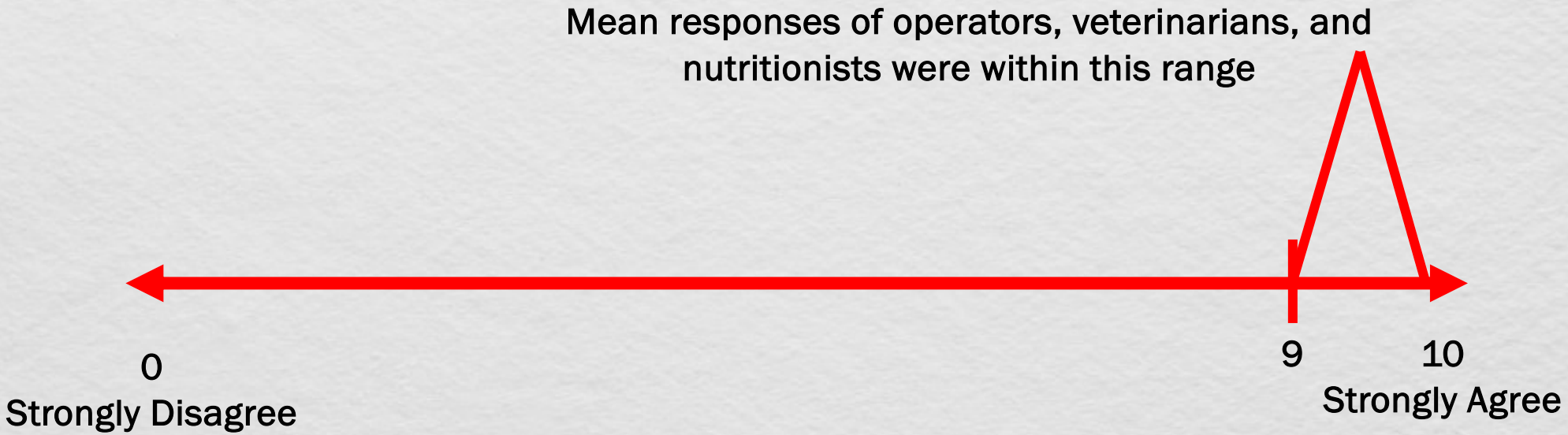
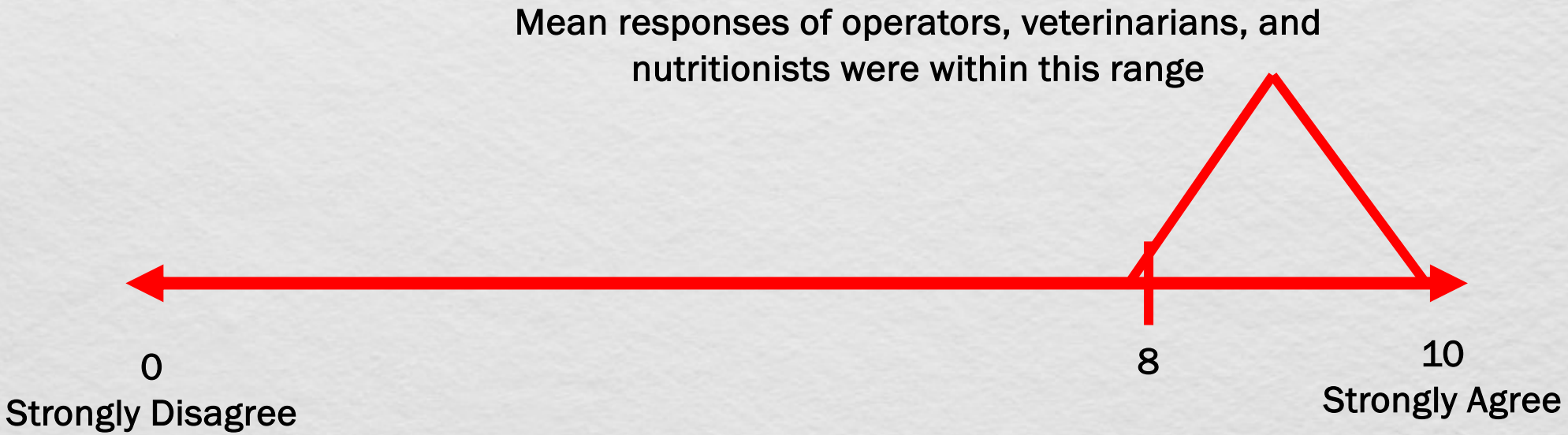
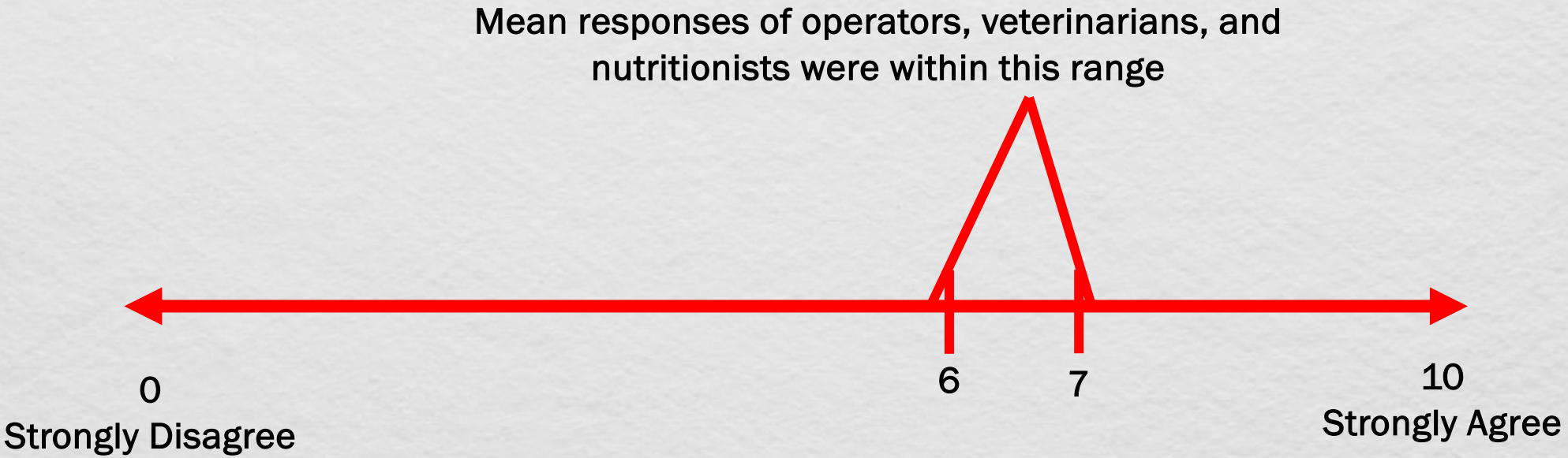
Heat stress negatively impacts cattle performance



Heat stress negatively impacts cattle welfare



Heat stress negatively impacts carcass quality



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Despite its importance, we do not know a lot about adoption or perception of heat stress mitigation strategies across the feedlot industry

Strategies generally focus on:

1) Adjusting feed
2) Water
3) Environment modifications
4) Handling changes

(Brown-Brandl, 2018)

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Recent survey on perceptions and use of heat stress mitigation strategies

The majority of respondents said they utilize or recommend heat mitigation strategies

Fewer had a written protocol describing implementation

Beef Quality Assurance℠

CERTIFIED ANGUS BEEF® BRAND

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What types of strategies did they use?
modifying feeding strategies

Table 3. Summary of respondents' answers by role (operators, n = 22; veterinarians, n = 26; nutritionists, n = 8) when asked if they utilize or recommend the listed heat stress mitigation strategies.

Survey Question –
For extreme heat events do you (or recommend to):

	Role (n, %)		
	Operator	Veterinarian	Nutritionist
modify feeding strategies during?			
Yes	12, 54.5%	20,76.9%	8, 100%
No	10, 45.5%	6, 23.1%	0, 0%
No answer	0, 0.0%	0, 0.0%	0, 0%
modify feeding strategies after?			
Yes	16, 72.7%	17, 65.4%	5, 62.5%
No	6, 27.3%	9, 34.6%	3, 37.5%
No answer	0, 0.0%	0, 0.0%	0, 0%

Ration Composition and Heat Production

High

- High fiber roughages
- low quality hay or straw

Mod

- Grains/highly digestible roughages
- silage

Low

- Fats
- Oils

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Materials and Methods

- Shade (SH)
  - Randomly allocated
  - 12.19 × 12.19 m^2
  - Covered 2 pens
  - Provided 7.2 ± 0.6 m^2 shade area per animal
- No Shade (NSH)

Dietary Treatment

LIM

ADLIB

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Receiving Experiment Conclusions

Limit-feeding

- ↑ ADG 4%
- ↑ G:F 42%
- ↓ Water usage 12%
- ↓ Mean panting score

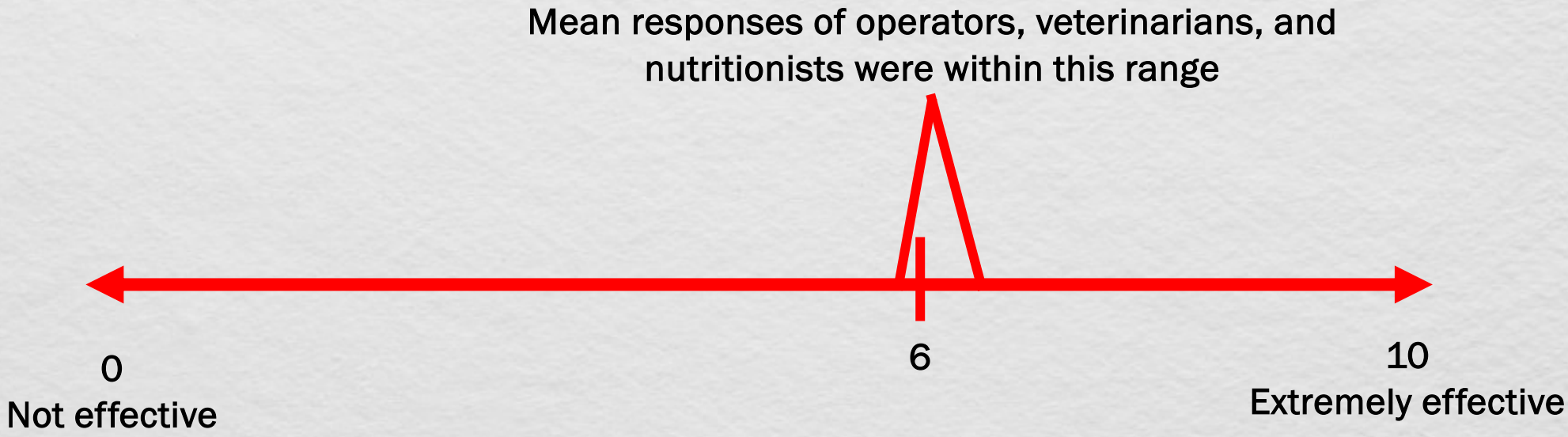
Shade

- ↑ BW
- ↑ ADG 7%
- ↑ DMI 6%
- ↑ G:F 4%
- ↓ Water usage 11%
- ↓ Mean panting score

A Big Thank You To:

- National Cattlemen's Beef Association, a contractor of the beef checkoff
  - Funding
- Strobel Manufacturing
  - Gracious loan of 10 Super Shades to conduct this research
- Most importantly:
  - Mr. Zack Debord (Master of this project)

How effective as it relates to minimizing the effects of heat stress is *changing feeding strategies*



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What types of strategies did they use? *water*

Table 3. Summary of respondents' answers by role (operators, n = 22; veterinarians, n = 26; nutritionists, n = 8) when asked if they utilize or recommend the listed heat stress mitigation strategies.

Survey Question – *For extreme heat events do you (or recommend to):*	**Role** (n, %) Operator	Veterinarian	Nutritionist
utilize a sprinkler system?			
Yes	5, 22.7%	16, 61.5%	6, 75%
No	16, 72.7%	10, 38.5%	2, 25%
No answer	1, 4.5%	0, 0.0%	0, 0%
water cattle down?			
Yes	5, 22.7%	12, 46.2%	5, 62.5%
No	16, 72.7%	13, 50%	3, 37.5%
No answer	1, 4.5%	1, 3.8%	0, 0%
provide bedding?			
Yes	10, 45.5%	22, 84.6%	6, 75%
No	11, 50%	4, 15.4%	2, 25%
No answer	1, 4.5%	0, 0.0%	0, 0%

Sprinklers

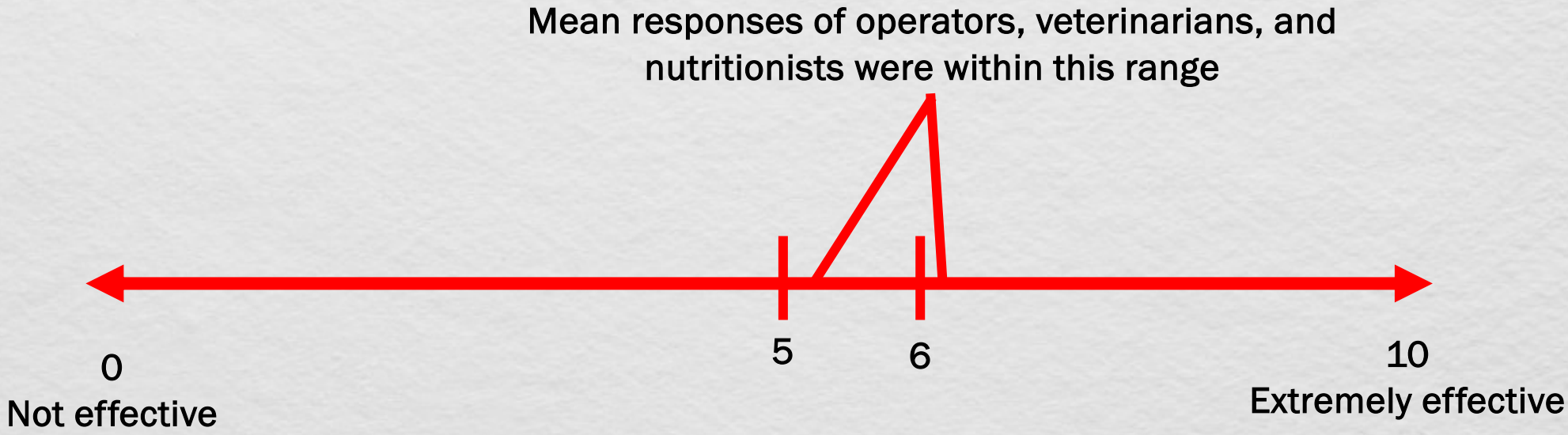
- Can be useful if used correctly
- Wet the animal and pen/Don’t mist
  - Droplet size matters (150 micron diameter)
- Very early in morning or overnight
  - Helps with overnight cooling before peak heat load
  - **Cools pen floor**
- Not for use in the middle of the day
  - Increases humidity in the pen microenvironment

Sprinkler's Effects?

- Improved feed conversion
- Reduced panting scores
- Reduced pen floor temperatures

Nebraska Beef Cattle Reports. (2001). 292.
Int J Biometeorol (2007) 51:541–551

How effective as it relates to minimizing the effects of heat stress is *using a sprinkler system*



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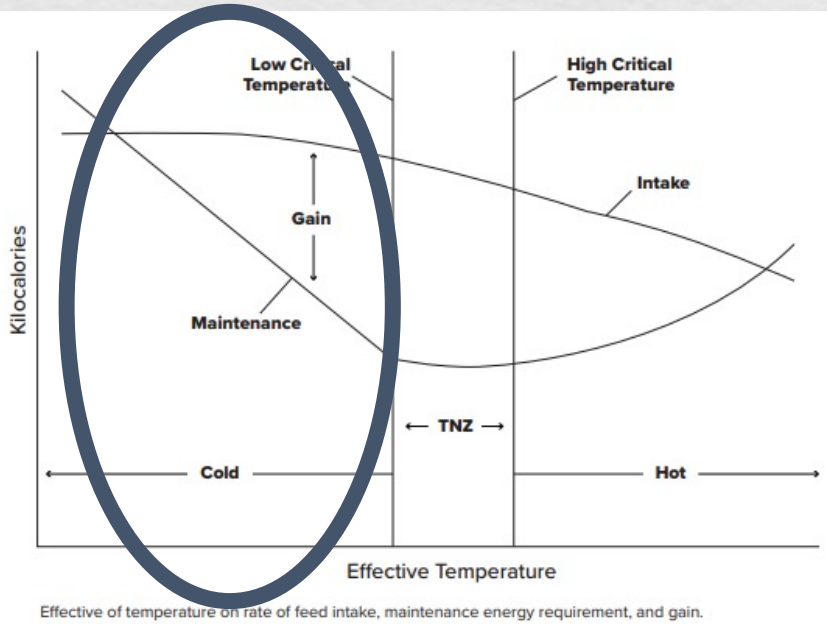
Bedding??

Treatment	Avg. Face Temp (°F)	Ambient Temp (°F)
Bare Floor	137	97
6” Manure	137	97
6” Straw	112	97

Environmental Stress-Cold



Effective of temperature on rate of feed intake, maintenance energy requirement, and gain.
Source: Ames (1980)

- Increases in energy requirement
- Storms, blizzards disrupt feeding behavior

[1] *Bond, T.E., W.N. Garrett, R.L. Givens and S.R. Morrison. 1970. Comparative effects of mud, wind and rain on beef cattle performance. Paper No. 70-406. Annu. Meeting A.S.A.E.*

Got a Plan?

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Good bedding pack composts, providing heat for cattle comfort

Bedding also improves pen conditions & minimizes manure tag on the hide

Impact of Bedding Cattle During Winter Months

- SDSU
- ~4lbs bedding/hd
- Increased DMI, G:F, ADG
- Decreased Maintenance
- **35 less days on feed**

Animals **2020**, 10, 1766

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Animal welfare to improve performance

Winter time mud ADG losses

No mud	0%
Dewclaw deep	7%
Shin deep	14%
Below hock	21%
Hock deep	28%
Belly deep	35%

1991, Beef Feeder, UNL

Mud

- Mud effects well established

TABLE 2. CATTLE PERFORMANCE AND RESULTING CALCULATED ENERGY LOSS VALUES FOR DIFFERENT LOT CONDITIONS

	Concrete lots		Muddy lots		Sprinkled lots
	1969	1970	1969	1970	1969 (4.83 mm/hr)
Av. Daily Gain, kg*	1.44	1.29	0.94	1.17	1.21
Av. Daily Feed Intake, kg*	10.2	8.5	8.6	8.0	10.2
Av. Initial Wt., kg*	296	223	298	225	294
Av. Final Wt., kg*	417	368	377	356	396
Calculated Energy Loss,† kcal/day	16,193	14,031	16,194	13,792	18,337

*Data from Bond et al. (1970)
†Calculations based from Teter et al. (1973)

G. L. Riskowski, J. A. DeShazer
MEMBER
ASAE

1976

FIG. 1 Experimental setup—1] attachment of hoof to Instron unit. 2] mud box 3] attachment of mud box to Instron unit by means of the movable crosshead.

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What types of strategies did they use? *handling changes*

Table 3. Summary of respondents' answers by role (operators, n = 22; veterinarians, n = 26; nutritionists, n = 8) when asked if they utilize or recommend the listed heat stress mitigation strategies.

Survey Question – *For extreme heat events do you (or recommend to):*	**Role** (n, %) Operator	Veterinarian	Nutritionist
change work hours?			
Yes	16, 72.7%	26, 100%	8, 100%
No	6,27.3%	0, 0.0%	0, 0.0%
No answer	0, 0.0%	0, 0.0%	0,0.0%
change processing/re-implanting/shipping times?			
Yes	20, 91%	25, 96.2%	8, 100%
No	1, 4.5%	1, 3.8%	0, 0.0%
No answer	1, 4.5%	0, 0.0%	0, 0.0%

What happens downstream when shipping times change?

Variable	*n*	Minimum	Mean	Maximum	SD
Transportation					
Distance Travelled (km)	604	2.7	155.8	1,332.5	209.6
Truck Waiting Time (minutes)	607	0.0	30.3	574.2	39.7
Lairage					
Lairage Duration (minutes)	572	4.0	200.7	1,071.5	195.0
Lairage Density (m^2/animal)	609	0.6	3.1	31.7	2.0
Environmental Characteristics					
THI[1, 2]	622	18.9	60.4	81.5	13.6
Precipitation[2] (inches)	622	0.0	0.001	0.1	0.01
Wind Speed[2] (mph)	622	0.0	11.2	35.0	6.3

n = 637 slaughter lots

82,469 cattle!!

[1]THI score was calculated using the equation: THI = 0.8*T + RH*(T-14.4) + 46.4 where T is ambient or dry-bulb temperature (°C) and RH is relative humidity expressed as a proportion (LiveCorp and Meat and Livestock Australia, 2023).[2]Temperature and humidity used to calculate THI, precipitation and wind speed were recorded using an online commercial weather service (Weather Underground, San Francisco, CA, USA).

This project was supported by the Agriculture & Food Research Initiative Competitive Grant no. 2019-67015-29578 from the USDA National Institute of Food and Agriculture.

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Do these pre-slaughter management factors impact cattle comfort?

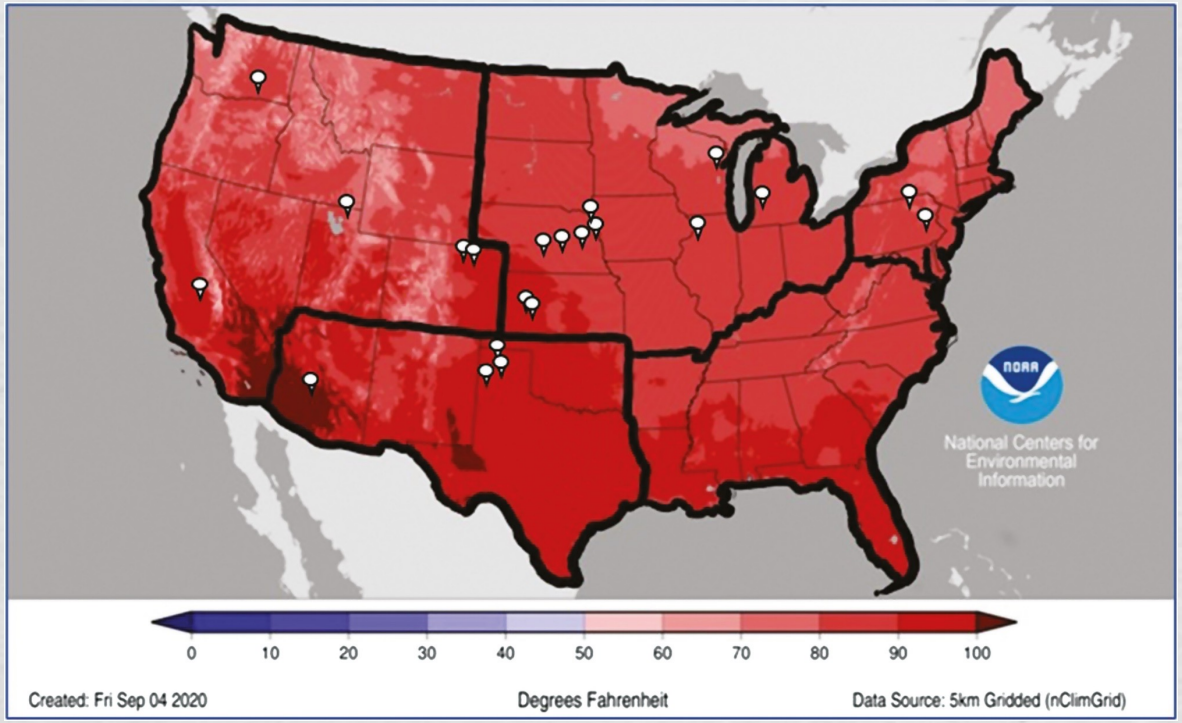
Mobility impacts cattle comfort at the plant (and economics)

As time to unload increased, the odds of having impaired mobility increased.

Carcass quality impact

As lairage time increased, the estimated odds of a carcass being classified as a dark cutter increased

How do we maximize comfort & performance at the plant?



- Plants use at least one type of heat mitigation strategy – many use multiple
- Survey sample:
  - Most common (81%) use sprinklers or misters
  - Followed by shade (33%) and fans (19%)

(Davis et al., 2022)

How do we maximize comfort & performance at the plant?

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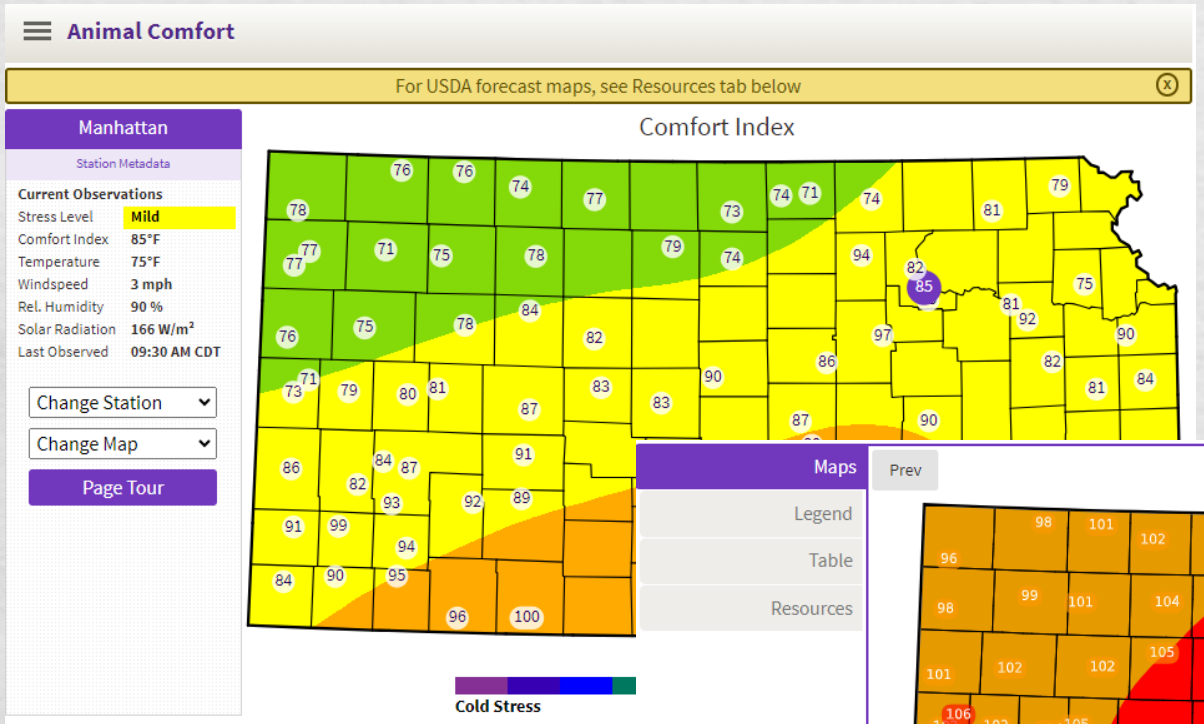
What resources would be helpful to you in regard to managing heat stress?

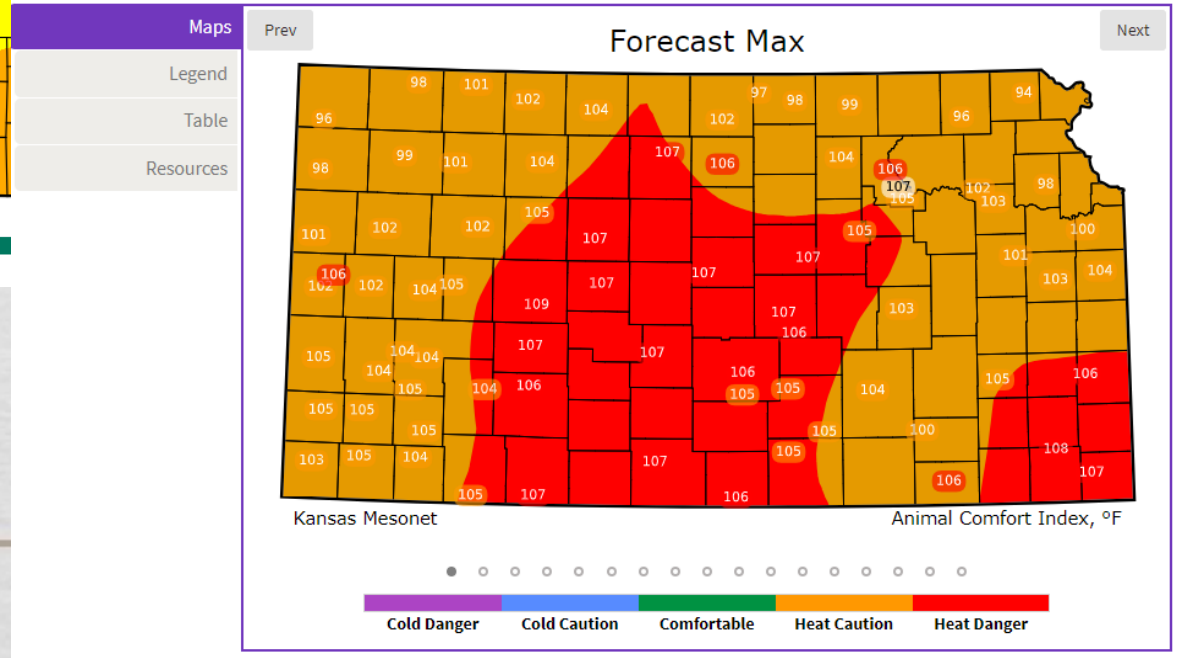
Monitoring Resources

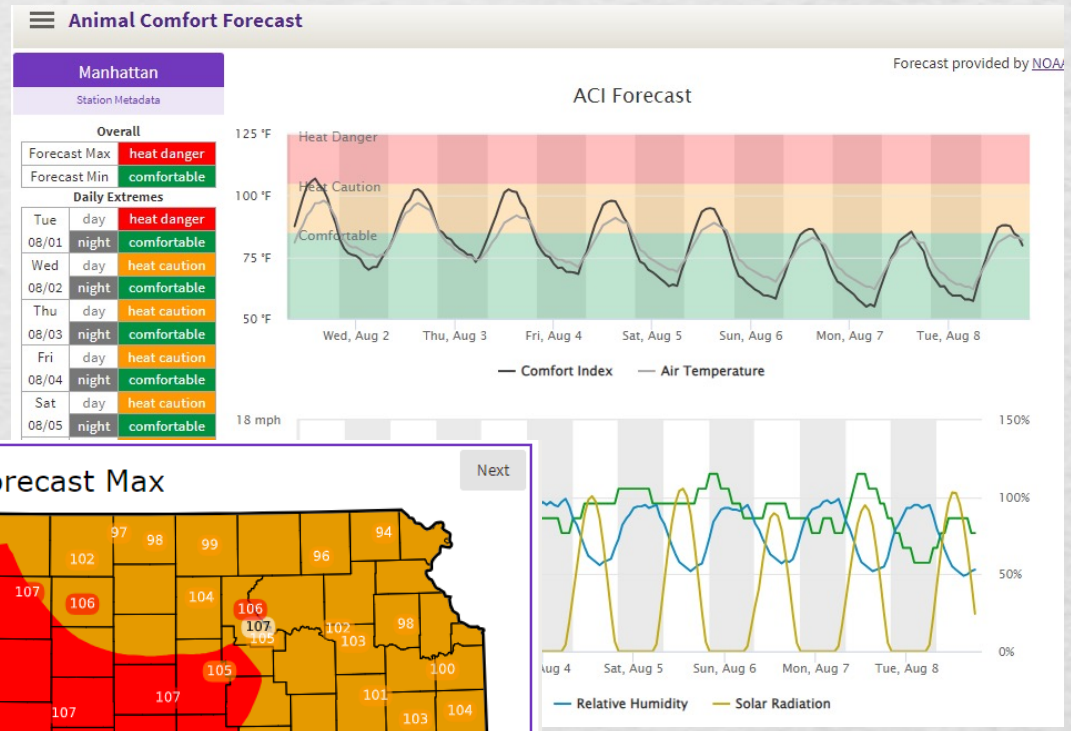
“We need better tools to predict heat stress. To me it’s more about how drastic the change is and how long cattle have had to acclimate.”

“An easy to use heat stress dashboard that predicts heat stress (THI) events.”

Kansas Mesonet







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What resources would be beneficial to the industry to deal with heat/cold stress challenges?

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Questions?

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