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Nilgai (*Boselaphus tragocamelus*) mortality levels in South Texas after historic freeze event

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ABSTRACT

Nilgai antelope (*Boselaphus tragocamelus*) are exotic bovids from India that are hosts of the exotic southern cattle fever tick (*Rhipicephalus microplus*) and are implicated in their spread throughout the landscape of South Texas. Recent historic cold temperatures caused significant mortality to nilgai, especially in parts of South Texas including northern Hidalgo and Kenedy Counties that experienced more than 11 consecutive hours below -3ºC. Mortality was minimal in Cameron Co., and northeastern Tamaulipas, Mexico which recorded only 5 and 6 hours below -3°C respectively. Extreme cold weather events are expected to limit the final distribution of nilgai in South Texas.

Additional index words: *Boselaphus tragocamelus,* cattle fever tick eradication program, nilgai, cold mortality

Nilgai antelope (*Boselaphus tragocamelus* Pallas) are in the family Bovidae and are closely related to domesticate cattle *Bos* spp. They were brought to the United States from India and released in South Texas circa1930 (Leslie 2008). By the early 1970s, nilgai were distributed in nine Texas counties and in northeastern Mexico (Presnall, 1958; Sheffield et al., 1983). Nilgai co-exist with cattle in South Texas and are competent hosts of the southern cattle fever tick, *Rhipicephalus microplus* (Canestrini) (Perez de Leon et al. 2012, Olafson et al. 2018). Cattle fever ticks transmit an important tick-borne disease, bovine babesiosis caused by *Babesia bovis* and *Babesia bigemina* (Davis et al. 2020). Bovine babesiosis was once endemic in the southern United States and caused severe losses to the cattle industry; however, this disease and its vectors were eradicated from the United States by 1943 by the United States Department of Agriculture - Animal and Plant Health Inspection Service (USDA-APHIS) and other state and federal agencies under the Cattle Fever Tick Eradication Program (Giles et al. 2014, USDA 2019). Nilgai move widely throughout this environment and are implicated in the spread of cattle fever ticks in South Texas, and, therefore necessitate the establishment of cattle fever tick quarantine areas that regulate the movement of cattle and other host animals (Texas Animals Health Commission 2016, Foley et al. 2017). The final adventive range of nilgai in south Texas, USA and northeastern Mexico is not known, because their distribution is still expanding. Being native to tropical and subtropical climates of India, Pakistan, and Bangladesh, their cold tolerance is limited and will likely affect their long-term distribution (Sankar et al. 2004). The final range of nilgai is important to know because of their ability to disperse cattle fever ticks over long distances in South Texas. Some data on cold tolerance was reported in an ecological study conducted in the state of Haryana, India (northern part of native range). In this study a low temperature of 8°C in January and a high of 44.6°C in June 1990 was recorded in Hisar, Haryana (Singh 1990). The record low for Hisar (29.1492° N, 75.7217° E) is -3°C, indicating that the native range does not experience extended freeze events. The climate of Hisar is classified as subtropical (Cw) in the Köppen-Geiger climate classification. The CLIMEX match climates index for Hisar as compared to Brownsville, TX, USA is 74% indicating both locations have very similar climates, although the latter is subject to more variation (Sutherst et al. 2004).

Although not quantitatively documented, Lohmeyer et al. (2018) believed that the historic cold temperature events in south Texas during the 1980's caused considerable nilgai mortality. The low temperatures in

Brownsville reached -7ºC on December 24, 1983 and -9ºC on December 22 in 1989 (Travis 2008). The historic low temperature in Brownsville was -11ºC on February 12, 1899. The average low temperatures for December, January, and February in Brownsville are 10, 11, and 12ºC respectively. Between February 14-20, 2021, deep South Texas experienced the seventh coldest temperatures since 1899. In this study we documented the extreme temperatures recorded in 2021 and its impact on nilgai mortality.

METHODOLOGY

The current known distribution of free-ranging nilgai in South Texas and northeastern Mexico is shown in Fig. 1. Nilgai mortality was conducted within 5 days of the freezing weather which ended on Feb. 20, 2021. Ranches were selected based on convenience of access and geographic distribution (Fig. 1).

Visual counts of live and dead nilgai were conducted by driving ranch roads and fence lines and recording the time for each survey.

Counts were conducted promptly to avoid loss of carcasses to predators and scavengers. Anecdotal reports of mortality were received from other parts of South Texas, but this is not reported. Weather data were collected from weather stations operated by the National Oceanic and Atmospheric Administration, National Weather Service, and cooperators (Fig. 2) (NOAA 2021). Some key weather stations lost power during the extreme weather event and data were not available. Analysis and basic data preprocessing were conducted in the statistical software package R (R Core Team, 2020). A linear regression analysis was used to estimate the relationship between nilgai mortality and cold temperature exposure with the lm() function. Response variables tested included: duration of constant sub 0ºC exposure, 0ºC exposure with breaks, duration of constant sub -3ºC exposure, -3ºC exposure with breaks, and latitude. P-value statistics were derived through the regression analysis.

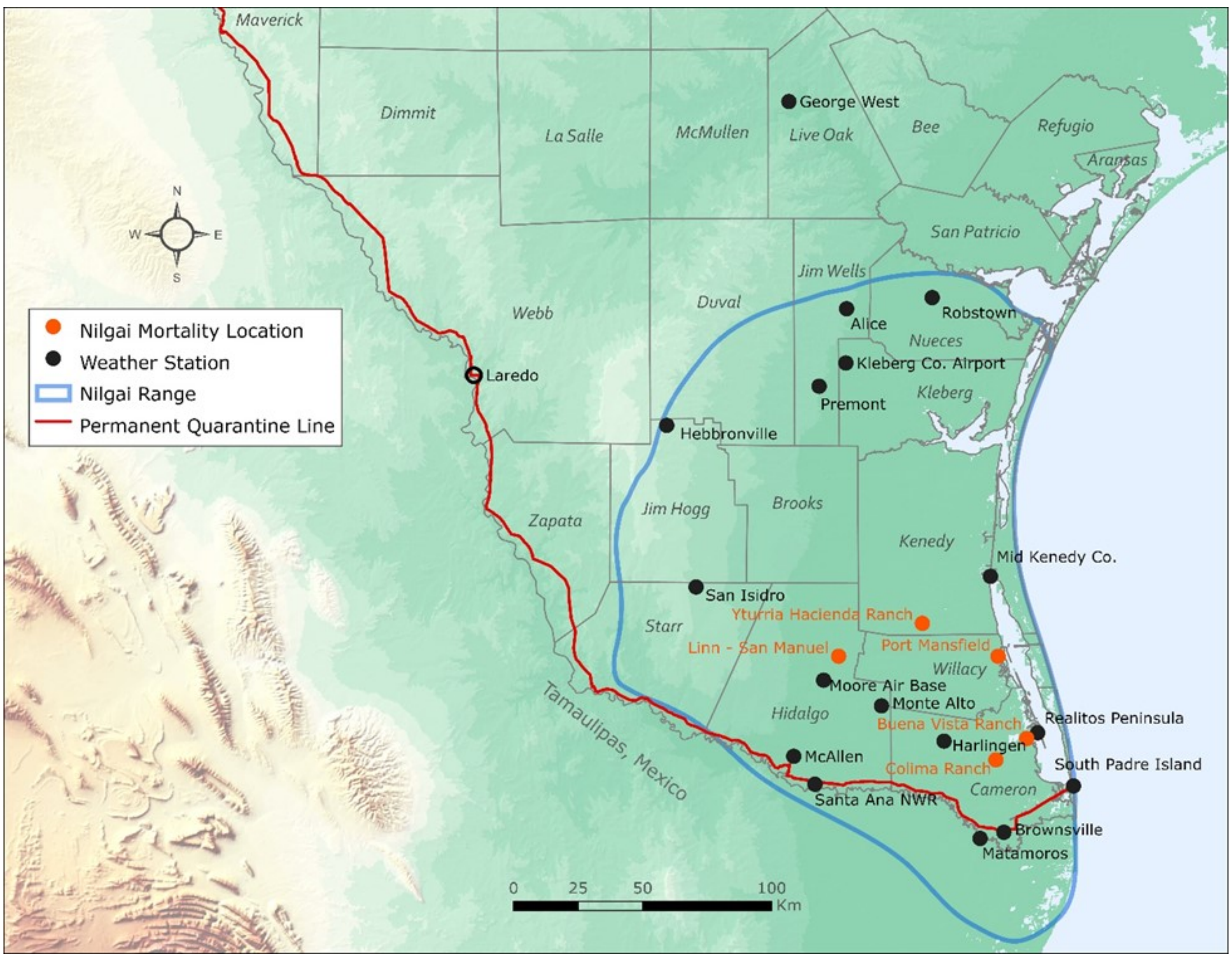

Figure 1. Geographical distribution area of the range of free-ranging nilgai, weather stations used in the study along with locations where data on nilgai mortality were collected during the cold weather event Feb. 14-20, 2021.

RESULTS AND DISCUSSION

The extreme freeze event in South Texas was created by a pool of arctic air that was brought into the northern Great Plains by a "piece" of the circumpolar vortex that slid south toward the Canadian/US border in early February (Fig. 2). Surface high pressure, reinforced by the presence of the piece of the vortex, moved into the northern and central Plains, then continued steadily southward, bringing subfreezing temperatures and winter precipitation into North and Central Texas around February 10, 2021. Much below average temperatures, but still above freezing, entered the Lower Rio Grande Valley late on February 11, 2021. A strong upper-level disturbance, extending from southwest Canada through northwest Mexico, slid eastward late on February14 and 15, 2021, bringing the seasonally unprecedented surge of frigid air deep into Mexico. Additional upper-level impulses crossed Texas through February 19, with the final wave exiting the state that day. Each impulse kept the much colder than average air in place. A warmup arrived on February 20, 2021.

Results and summary statistics of the regression analysis of the cold temperatures on nilgai mortality can be found in Table 1. The effect of time of constant exposure to sub -3ºC, time of constant exposure to sub 0ºC, and time of intermittent exposure to sub 0ºC were the strongest predictors ($P \leq 0.041$) of mortality. Latitude and longitude were not significant predictors of mortality. Nilgai mortality was minimal in southern Cameron County, but increased significantly to the north and west of Brownsville in correlation ($r = 0.9991$, $P \leq 0.023$) with the number of hours below -3ºC (Table 1). Although we only have anecdotal reports of mortality in the northern and western most parts of the range of nilgai, the consecutive hours below-3ºC near Hebbronville, Alice, Premont, and Robstown, TX with 17.5ºC, 17ºC, 15ºC, 12.5ºC respectively must have caused considerable mortality. We predict based on the first indication of mortality at Colima Ranch in southern Cameron County that more than 11 consecutive hours below-3ºC causes mortality to nilgai. Therefore, minimum winter temperatures normally experienced to the north and west of the current range of nilgai are likely to be a limiting factor in further range expansion in South Texas. Climate change may also be contributing to these extreme weather events that affect ecological processes (Ummenhofer and

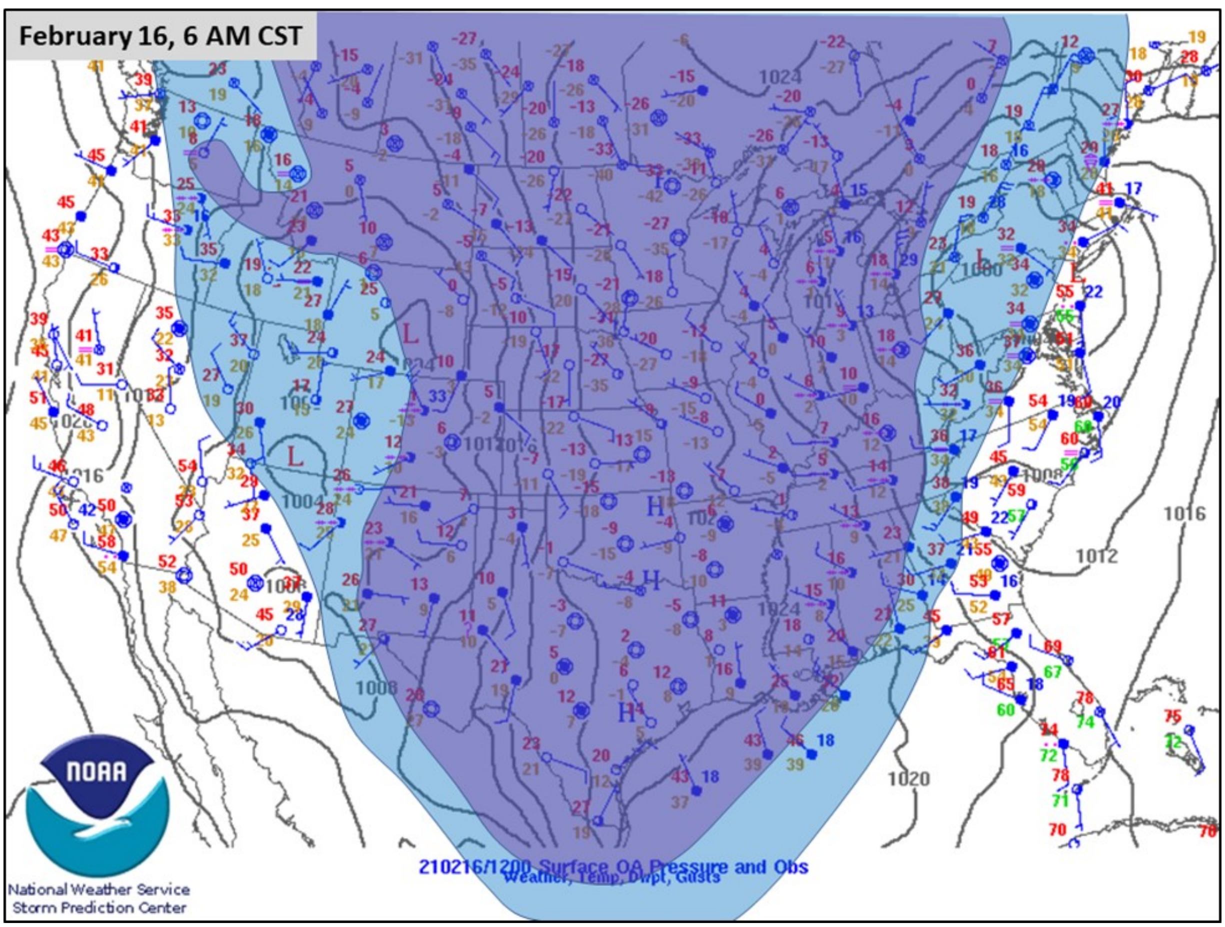

Fig 2. Surface air temperatures on February 16, 2021 in the Great Plains of North America.

Table 1. Temperatures in south Texas and northeastern Mexico during extreme cold event from Feb 14-20, 2021 and the impact on nilgai.

Location	Latitude	Longitude	Duration ≤ 0ºC Consecutive	Duration ≤ 0ºC With Breaks	Duration ≤-3ºC Consecutive	Duration ≤ -3ºC With Breaks	Absolute Min ºC	%Dead	No. of nilgai/hour searched
Kerrville, TX, Kerr Co.	30.047433	-99.1403189					-15.56		
San Antonio, Bexar Co.	30.807	-98.335556					-12.22		
Del Rio, Val Verde Co.	29.370886	-100.89587					-11.67		
Laredo, Webb Co.	27.506748	-99.502914					-7.78		
Victoria, Victoria Co.	28.798952	-97.028503					-10.56		
George West, Live Oak Co.	28.4659	-98.2524	89	--	19	34	-8.89		
Hebbronville, Jim Hogg Co.	27.3333	-98.7333	45.5	84	17.5	32	-9.44		
Robstown, Nueces Co	27.7783	-97.6903	21	38.5	12.5	22.5	-6.67		
Premont, Brooks Co.	27.47	-98.1358	36.5	49.5	15	29	-7.78		
Alice, Jim Wells Co.	27.7411	-98.0269	40	--	17	--	-8.33		
San Isidro, Starr Co.	26.7688	-98.6181	19.5	46	13.5	24	-7.78		
Mid Kenedy Co. by Bay	26.8017	-97.47	40.5	42.5	16	13.5	-7.78		
Yturria Hacienda Ranch, Kenedy Co.	26.643056	-97.738611	30	40	12	18.5	-7.78	27.3	80.5
South Padre Island, Cameron Co.	26.0667	-97.155	28	28	9	9	-5.56		
Kleberg Co. Airport, Kleberg Co.	27.5509	-98.0309	18	34.5	9	18.5	-6.11		
Linn - San Manuel, Hidalgo Co.	26.5258	-98.0633	18	39	11	21	-6.67	36.8	7.6
Port Mansfield, Willacy Co.	26.525556	-97.448611	19.5	43	10.5	18.5	-6.67	2.1	22.3
Realitos Peninsula, Cameron Co.	26.255278	-97.297222	29	29	10	10	-6.11		
Moore Air Base, Hidalgo Co.	26.4417	-98.1222	17.3	39	10.1	17	-6.11		
McAllen, Hidalgo Co.	26.1758	-98.2386	15	32	5.5	10.5	-5.56		
Monte Alto, Hidalgo Co.	26.3518	-97.8973	20	37	8	24	-6.11		
Santa Ana NWR, Hidalgo Co.	26.0786	-98.1572	15.5	30	9.5	15	-6.11		
Harlingen, Cameron Co.	26.2271	-97.6551	19.5	--	8.5	--	-5.56		
Colima Ranch, Cameron Co.	26.175619	-97.464584°	17.5	32.5	8.5	11.5	-5.56	1.5	44.5
Buena Vista Ranch, Cameron Co.	26.254534	-97.336021°	17.5	32.5	8.5	11.5	-5.56	0	30.6
Brownsville, Cameron Co.	25.9061	-97.426	16.5	--	5	--	-5.56		
Matamoros, Mexico	25.8858	-97.5186	17	27	6	6	-4.44		
P-value of Significant Predictor Variables to %Dead			0.041	0.033	0.023				

Meehl 2017). More research is needed to understand the effects of climate on the distribution of nilgai, due to its critical link with invasive cattle fever ticks.

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