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PATHOGEN PREVALANCE IN AMERICAN BLACK BEARS (*URSUS AMERICANUS AMBLYCEPS*) OF THE JEMEZ MOUNTAINS, NEW MEXICO, USA

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ABSTRACT: Informed management of American black bears (*Ursus americanus*) requires knowledge of the distribution and pathology of diseases affecting the species. Little information is available on pathogen prevalence from black bear populations in the Southwest, US, and it is unknown how these infections may influence black bear populations or disease transmission. We captured New Mexico black bears (*Ursus americanus amblyceps*) during 2016–17 as part of a long-term monitoring project and opportunistically collected 36 blood samples from 12 female and 17 male black bears. We wanted to determine prior exposure to canine distemper virus, canine parvovirus, *Yersinia pestis*, *Francisella tularensis*, West Nile virus, *Toxoplasma gondii*, and the tick-borne pathogens, *Anaplasma* spp., *Ehrlichia* spp., *Borrelia burgdorferi*, *Rickettsia* spp., and *Babesia* spp. Approximately half (55%, 16/29) of the individuals sampled had antibodies to *Y. pestis*, and 37% (10/27) had antibodies to *T. gondii*. Prevalence of antibodies to West Nile virus, *F. tularensis*, and canine parvovirus were lower (i.e., 11, 10, and 3%, respectively). We detected no antibodies to canine distemper, *B. burgdorferi*, *Rickettsia* spp., or *Babesia* spp. We documented changes in antibody titer levels for both sexes of several recaptured black bears. Our data will inform managers of pathogen prevalence and distribution in black bears in north-central New Mexico and provide a vital baseline dataset for future pathogen monitoring. Additionally, these data support actions to minimize exposure through handling wild individuals or through hunter harvest activities.

Key words: Black bear, New Mexico, pathology, plague, serology, *Ursus americanus*, wildlife disease.

INTRODUCTION

Wildlife endures many challenges affecting survival and fitness. Among these challenges is the exposure to various pathogens that threaten vitality (Miller et al. 2000; Murray et al. 2006). Pathogens may influence individual animals, their offspring, and current and future population productivity (O'Brien and Evermann 1988; Cassirer et al. 2018). Exposure can occur through various contacts with sympatric species, such as when competing for foraging opportunities, during territorial disputes, or through predator-prey interactions (Stephenson et al. 2015). Additionally, pathogens can be contracted through the air, through contact with saliva or scat, or through contaminated food, water, or soil (Zarnke et al. 2000); therefore, pathogens may persist after an infected animal has left an area or is removed from the population.

Black bears (*Ursus americanus*) are an ideal species to monitor for pathogens because they are long-lived, wide-ranging, and are often captured for various research and management purposes. In addition to increased transmission to conspecifics, other wildlife species, and domestic animals, black bears may also become a vector to humans because the species is subjected to harvest in many states throughout the US. Certain pathogens, such as *Toxoplasma gondii*, are known to affect humans, and *T. gondii* may also be present in black bears (Dubey and Jones 2008). During droughts and periods of limited forage, black bears may travel long distances to meet their nutritional requirements (Hellgren et al. 2005), increasing the probability of interactions with humans and domestic ani-

mals (Baruch-Mordo et al. 2014), potentially increasing the risk of disease transmission. Pathogen transmission may also be a concern in areas in which black bear home ranges overlap with threatened or endangered species, such as Canada lynx (*Lynx canadensis*) in north-central New Mexico (Frey 2006). Black bears are often considered intermediate hosts for several pathogens (Bronson et al. 2014), although they are known to scavenge prey from definitive hosts (Elbroch et al. 2015) and consume some pathogen hosts, such as rabbits (Leporidae) and rodents (Rodentia; Lesmerises et al. 2015; Kindschuh et al. 2016). Recognition of all factors that influence demographic rates, including pathogen prevalence and disease transmission rates, will allow for the development of more-effective management plans.

During 2016–17, we captured New Mexico black bears (*Ursus americanus amblyceps*) as part of a long-term study to determine the influence of wildfires and forest restoration treatments on black bear habitat use in the Jemez Mountains of north-central New Mexico (Bard 2018). During these captures, we opportunistically gathered blood samples to obtain baseline data on prior exposure to various pathogens known to occur in black bears in the US and those thought to potentially occur in this subspecies. Our objective was to determine prior exposure to canine distemper virus (CDV), canine parvovirus (CPV), *Yersinia pestis* (plague), *Francisella tularensis* (tularemia), West Nile virus (WNV), *Toxoplasma gondii* (toxoplasma), and five tick-borne pathogens, including *Anaplasma* spp. (ANAP), *Ehrlichia* spp. (EHRL), *Borrelia burgdorferi* (BORR), *Rickettsia* spp. (RICK), and *Babesia* spp. (BABE).

MATERIALS AND METHODS

Study area

Our study occurred within 85,000 ha in the Jemez Mountains, New Mexico, US, during 2016–17 (Fig. 1). Lands are primarily managed by the US Forest Service and National Park Service as part of the Santa Fe National Forest (SFNF) and the Valles Caldera National Preserve (VCNP) but also included tribal lands managed by the Jemez Pueblo. Topography varied from resurgent volcanic domes surrounded by grasslands in the VCNP to steep ridges, rock outcrops, canyon lands, and mesas in the SFNF; elevation ranged from 1,795 m to 3,431 m. Mesic, high-elevation sites were associated with mixed-conifer communities. Mid-elevations were characterized by ponderosa pine (*Pinus ponderosa*) forests and oak (*Quercus* spp.) shrubland and quaking aspen (*Populus tremuloides*) stands, which were often located in mixed-vegetation communities. Lower elevations predominately consisted of pinyon-juniper (*Juniperus* spp., *Pinus edulis*) woodlands. Mean (SD) yearly precipitation ranges from 43 (25) cm at low elevations (e.g., 2,195 m) to 58 (25) cm at high elevations (e.g., 2,471 m). Mean snowfall ranges from 73 (40) cm to 305 (97) cm at low and high elevations, respectively (Western Regional Climate Center 2016). The area is characterized by a monsoon precipitation cycle, with most rainfall occurring from June through September (National Oceanic and Atmospheric Administration 2016). Mean daily high temperatures at low elevations is 31 (1.0) C in July, whereas mean daily low temperatures are –6 (1.9) C in January. At high elevations, the mean daily high temperature is 25 (0.9) C in July and mean daily low temperatures are –14 (2.1) C in January. Topography and weather directly affect black bear forage availability because black bear diets consist predominately of vegetation (Rogers 1987). Precipitation patterns and rates of vegetation maturation interact with black bear nutritional requirements resulting in seasonal shifts in forage consumption and spatial distribution (Garshelis and Pelton 1981) and an increased potential for pathogen transmission.

Common black bear forage included bear corn (*Conopholis americana*), Gambel oak (*Quercus gambelii*), pinyon pine, various soft mast–producing species (e.g., gooseberry [*Ribes uva-crispa*], desert prickly pear [*Opuntia phaeacantha*]), as well as various mushroom, conifer seeds, grasses, sedges, and forbs. Bears also foraged on various insects, carrion, elk (*Cervus canadensis*) and mule deer (*Odocoileus hemionus*) neonates, and small prey mammals, including rabbits and rodents (Lesmerises et al. 2015; Kindschuh et al. 2016). Although it is unknown whether black bears foraged on prairie dogs (*Cynomys* spp.), multiple colonies were located throughout the study area, one of which disappeared in 2017 resulting from an outbreak of the plague. The black bear density estimate for the Jemez Mountains is 17 bears/10,000 ha and is considered stable (New Mexico Department of Game and Fish 2018). The SFNF is open to fall black bear harvest outside the VCNP.

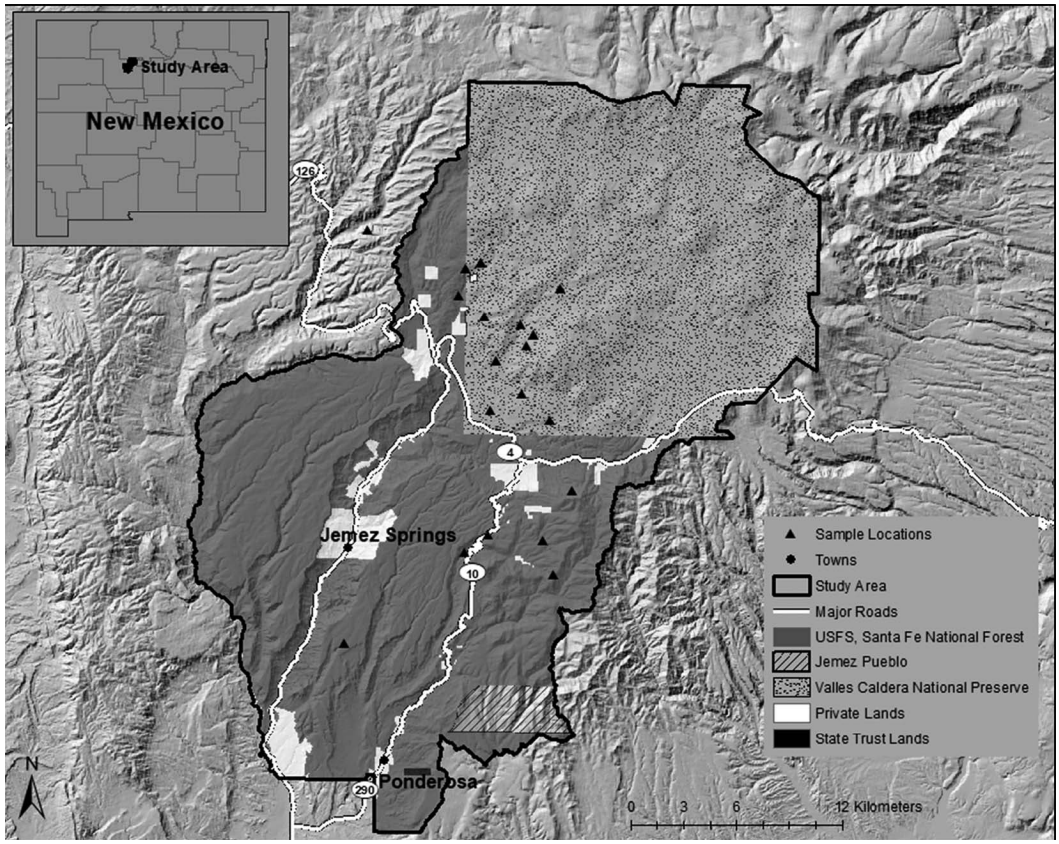

FIGURE 1. New Mexico black bear (*Ursus americanus amblyceps*) study area and sampling locations in the Jemez Mountains of north-central New Mexico, USA in 2016 and 2017 where blood samples were taken for testing for the seroprevalence of potential pathogens. USFS=US Forest Service.

Capture and monitoring

We captured black bears during the spring and summer of 2016–17 using Aldrich foot snares and culvert traps. We chemically immobilized black bears with 4.4 mg/kg ketamine (Ketaset, Fort Dodge Animal Health, Overland Park, Kansas, USA) and 2 mg/kg xylazine (Anased, Lloyd Inc., Shenandoah, Iowa, USA) or 3 mg/kg tiletamine-zolazepam (Telazol, Zoetis Inc., Kalamazoo, Michigan, USA) and 2.2 mg/kg xylazine (Kreeger and Arnemo 2012) via a CO_2 dart pistol (Dan-Inject, Børkop, Denmark) or pole syringe (Tomahawk, Hazelhurst, Wisconsin, USA). All captured bears were measured, identified by sex, and classified by age as cub of the year, yearling (1 yr old), subadult (2–3 yr old), and adult ($\geq$4 yr old), based on tooth eruption and wear (LeCount 1986). We fitted adult black bears with GPS telemetry collars (G2110E, Advanced Telemetry Systems, Isanti, Minnesota, USA) equipped with a very–high-frequency transmitter and a break-off device. We checked the fit of collars on all previously captured bears in their dens during January–March of 2016 and 2017. Collars were adjusted, replaced, or removed as necessary. Upon completion of handling, we administered 0.15 mg/kg yohimbine hydrochloride (Tocris Bioscience, Minneapolis, Minnesota, USA) or 2 mg/kg tolazoline hydrochloride (Zoopharm, Windsor, Colorado, USA) to reverse the effects of xylazine. All animal-handling procedures were approved by the New Mexico State University Institutional Animal Care and Use Committee (protocols 2011-028 and 2015-022) and followed acceptable methods (Sikes et al. 2016).

Blood collection and analysis

We collected blood from the femoral artery and placed it in three 5-mL serum-separator tubes with gel-clot activators and two 4-mL dipotassium-ethylenediaminetetraacetic acid (K_2-EDTA) tubes. We allowed blood collected in serum tubes to clot at ambient temperature before centrifuging $\leq$2 hr after collection to separate the serum

and red blood cell fractions. We stored samples at 1.6 C and submitted them to the New Mexico Department of Agriculture's Veterinary Diagnostic Services (VDS) in the New Mexico Scientific Laboratories (Albuquerque, New Mexico, USA) within 3 d of collection. The VDS assayed canine distemper and canine parvovirus with enzyme-linked immunosorbent assay tests. Individuals were classified as positive (antibodies against the pathogen detected) or negative (antibodies not detected). Plague and tularemia titers were determined by VDS with hemagglutination assay-hemagglutination inhibition assay and microscopic agglutination tests, respectively. Blood samples were considered positive if the *Y. pestis* F1 titer was ≥1:16. A single-specimen titer of ≥1:128 was considered positive for *F. tularensis*. West Nile virus tests (plaque-reduction neutralization test) were conducted by the National Veterinary Services Laboratories (Ames, Iowa, USA). Samples were considered positive for WNV-neutralizing antibodies if ≥1:100. Toxoplasma microscopic agglutination (immunoglobulin G) tests were conducted by Colorado State University Veterinary Diagnostic Laboratories (Fort Collins, Colorado, USA) until July 2016. Titers ≥1:40 were considered positive for antibodies. After July 2016, toxoplasma analyses were completed by the Veterinary Medical Center Biomedical and Diagnostic Sciences (Knoxville, Tennessee, USA), and titers ≥1:32 were considered positive for *T. gondii*. Tick-borne disease PCR panels were completed at the University of Georgia Veterinary Diagnostic Laboratories (Athens, Georgia, USA) for ANAP, EHRL, BORR, RICK, and BABE with whole-blood samples collected in EDTA tubes. The ANAP and EHRL tests were reported as one result. A positive PCR result indicated that the nucleic acid of that organism was detected in the sample.

RESULTS

We collected 36 samples from 29 individual bears (12 female [eight adults, three subadults, and one yearling] and 17 males [eight adults, three subadults, and six yearlings]). There were six individual bears resampled; one of these bears was resampled twice. There were four resamples collected in the winter den after spring or summer capture. The three other samples were collected after 13, 23, and 210 d after initial capture. We were not able to conduct every test for some sampled bears when the blood sample was insufficient. No mortality resulted from pathogen exposure, but one bear was killed by a hunter, and two bears were killed for causing public nuisance. Black bears were briefly handled but did not manifest clinical effects. No obvious lesions of ectoparasites (e.g., fleas, ticks) were evident on any of the bears, although it is possible that they were overlooked because there was not a systematic procedure to identify them. Five bears handled in their den showed signs of dermatitis, which was presumably mange; prevalence of similar symptoms was previously observed in 23% of black bears handled in winter dens in New Mexico (Costello et al. 2006). We did not analyze geographic patterns of sample results because of the large home ranges of black bears and their widespread spatial movements throughout the study area each year.

Canine distemper and canine parvovirus

All black bears were tested for CDV and CPV, but none had positive titers for recent exposure to CDV, and only one male bear (3%, 1/29) tested positive for antibodies against CPV. After a resample of the same bear 23 d later, the test was negative.

Yersinia pestis

Of black bears tested for *Y. pestis*, 55% (16/29) tested positive. A total of 42% (5/12) adult females tested positive, and 65% (11/17) of the male bears tested positive. Six bears were resampled and tested for *Y. pestis* exposure; there were no changes for four of the six bears, although the time between sampling varied between 23 d and 354 d. However, one female bear demonstrated a reduction in antibodies when sampled again, 285 d later in her den, whereas a male bear, sampled two times over a period of 13–210 d after the initial capture, indicated increased antibodies later (Table 1).

Francisella tularensis

There were 10% (3/29) of black bears sampled that tested positive for *F. tularensis* antibodies (Table 1). Samples that indicated previous exposure were all from female bears; two were adults, and one was a subadult.

TABLE 1. Detection of antibodies to four pathogens in serum samples from American black bears (*Ursus americanus amblyceps*) in the Jemez Mountains, New Mexico, USA, during 2016–17.[a]

				Yersinia pestis		*Francisella tularensis*		West Nile virus		*Toxoplasma gondii*	
Year and bear	Age	Sex	Date	Titer	Result	Titer	Result	Titer	Result	Titer	Result
2016											
URAM38	Adult	F	11 March	<1:4	Neg	<1:4	Neg	NA	NA	NA	NA
URAM47	Adult	F	14 March	1:256	Pos	1:8	Neg	NA	NA	NA	NA
URAM53	Adult	M	20 May	<1:4	Neg	<1:4	Neg	≥1:100	Pos	≥1:8192	Pos
URAM54	Adult	F	23 May	1:512	Pos	1:128	Pos	1:10	Neg	<1:40	Neg
URAM55	Adult	F	26 May	1:512	Pos	<1:4	Neg	1:10	Neg	1:512	Pos
URAM56	Subadult	M	29 May	<1:4	Neg	1:16	Neg	1:10	Neg	<1:40	Neg
URAM30	Adult	M	31 May	1:64	Pos	1:32	Neg	1:10	Neg	<1:40	Neg
URAM57	Adult	M	2 June	<1:4	Neg	1:8	Neg	1:10	Neg	<1:40	Neg
URAM58	Adult	M	5 June	1:64	Pos	1:8	Neg	1:10	Neg	≥1:8192	Pos
URAM59	Adult	M	11 June	1:128	Pos	1:8	Neg	1:10	Neg	1:4096	Pos
URAM53	Adult	M	12 June	<1:4	Neg	1:8	Neg	≥1:100	Pos	1:2048	Pos
URAM60	Yearling	M	12 June	1:256	Pos	<1:4	Neg	1:10	Neg	<1:40	Neg
URAM61	Adult	F	14 June	<1:4	Neg	1:8	Neg	1:10	Neg	<1:40	Neg
URAM57	Adult	M	15 June	1:64	Pos	1:16	Neg	1:10	Neg	<1:40	Neg
URAM62	Adult	M	28 June	1:128	Pos	1:8	Neg	≥1:100	Pos	1:2048	Pos
URAM63	Subadult	F	29 June	<1:4	Neg	<1:4	Neg	1:10	Neg	<1:40	Neg
URAM64	Adult	F	24 July	1:128	Pos	1:32	Neg	1:10	Neg	1:2048	Pos
URAM65	Yearling	M	28 July	1:1024	Pos	<1:4	Neg	1:10	Neg	1:512	Pos
URAM66	Yearling	M	28 July	<1:4	Neg	<1:4	Neg	1:10	Neg	<1:32	Neg
URAM67	Yearling	F	31 July	<1:4	Neg	<1:4	Neg	1:10	Neg	1:32	Pos
URAM68	Yearling	M	2 August	1:128	Pos	<1:4	Neg	1:10	Neg	<1:32	Neg
URAM69	Subadult	M	20 August	1:64	Pos	<1:4	Neg	1:10	Neg	<1:32	Neg
URAM70	Yearling	M	25 August	1:16	Pos	<1:4	Neg	1:10	Neg	<1:32	Neg
2017											
URAM57	Adult	M	11 November	1:128	Pos	1:8	Neg	1:10	Neg	<1:32	Neg
URAM58	Adult	M	14 November	1:64	Pos	1:4	Neg	1:10	Neg	1:2048	Pos
URAM71	Subadult	M	5 March	1:64	Pos	1:8	Neg	1:10	Neg	<1:32	Neg
URAM55	Adult	F	7 March	1:32	Pos	<1:4	Neg	1:10	Neg	1:512	Pos
URAM64	Adult	F	8 March	1:128	Pos	1:8	Neg	1:10	Neg	1:512	Pos
URAM72	Subadult	F	17 April	<1:4	Neg	<1:4	Neg	1:10	Neg	<1:32	Neg
URAM73	Subadult	F	26 May	<1:4	Neg	1:256	Pos	1:10	Neg	<1:32	Neg
URAM35	Adult	M	28 May	<1:4	Neg	1:32	Neg	1:10	Neg	<1:32	Neg
URAM74	Adult	F	29 May	1:128	Pos	1:32	Neg	1:10	Neg	1:512	Pos
URAM33	Adult	F	31 May	<1:4	Neg	1:128	Pos	1:10	Neg	≥1:8192	Pos
URAM59	Adult	M	31 May	1:128	Pos	1:16	Neg	≥1:100	Pos	1:2048	Pos
URAM75	Yearling	M	5 June	<1:4	Neg	<1:4	Neg	1:10	Neg	<1:32	Neg
URAM76	Adult	M	11 June	<1:4	Neg	<1:4	Neg	1:10	Neg	<1:32	Neg

[a] F = female; M = male; pos = positive; neg = negative; NA = individual not tested because of an insufficient blood sample.

West Nile virus

Antibodies to WNV were found in 11% (3/27) black bears sampled (Table 1). One male bear was sampled twice, and the results were the same for both samples. A total of 18% (3/17) of tested male bears were positive.

Toxoplasma gondii

We found that 37% (10/27) of the black bears tested positive for *T. gondii*. About 50% (5/10) of the females and 29% (5/17) of the males tested positive. All antibody titers to *T.*

gondii were relatively high (e.g., ≥1:8192; Table 1).

Tick-borne PCR panel

Negative PCR results indicated that the nucleic acid of BORR, RICK, and BABE was not detected in any of the 25 samples tested. Only 4% (1/25) sampled from a subadult female bear tested positive for ANAP-EHRL.

DISCUSSION

Canine distemper and canine parvovirus

Reports of CDV and CPV are limited for black bears. Only one bear in our study tested positive for CPV; however, an additional sample collected 23 d later was negative, suggesting an initial false positive. A low prevalence of antibodies has also been reported from tests of 40 black bears in Alaska (Chomel et al. 1998). A small percentage (5%, 8/165) of western black bears had documented antibodies to CDV in the Pacific Northwest, US (Mortenson 1998). However, higher prevalence of both viruses has been reported in black bear populations in the Eastern US (Dunbar et al. 1998; Bronson et al. 2014). For example, in Maryland, 29% (25/85) and 12% (10/82) of samples tested positive for CDV and CPV, respectively (Bronson et al. 2014). Cottrell et al. (2013) described the first report of a clinical disease in a yearling black bear exposed to CDV and stated the bear exhibited abnormal paws and a history of seizures. These viruses have a broad host range and are common in domestic and wild Canidae, Procyonidae, Mephitidae, and Mustelidae, causing infection in the gastrointestinal, nervous, ocular, cardiac, respiratory, and integumentary systems (Appel 1970). Their significance for New Mexico black bears, however, is still unknown.

Yersinia pestis

Black bears can be exposed to plague through flea bites or by consuming infected prey (Gage et al. 1994). Although rodents make up a small percentage of black bear diets (Lesmerises et al. 2015), it is possible they are significant food sources during periods of limited forage, which may increase risk of transmission. The overall seroprevalence (55%) for this study was higher than reported elsewhere, despite our relatively small sample size. Surveys for plague in California black bears reported prevalences from 15% to 40% (Barnes 1982; Ruppanner et al. 1982; Smith et al. 1984; and Clover et al. 1989). Mortenson (1998) collected 198 samples from five study areas in Washington, Oregon, and northern California, and only 11 bears (6%) from three sites in Oregon and California tested positive for plague. In the US, plague is associated with various vegetation types, and the distribution of this pathogen may vary among environments as well as host species (Adjemian et al. 2007). The Southern Rockies had a higher incidence and rate of plague transmission compared with other ecoregions in the West (Adjemian et al. 2007). This occurrence may be detected in prairie dog populations that are widely distributed throughout open habitats and are highly susceptible to this infection (Antolin et al. 2002).

Francisella tularensis

Tularemia is reported in Rodentia and Lagomorpha of Utah, and it is suggested that sources of this pathogen are ticks, fleas, and lice (Thorpe et al. 1965). We detected a low prevalence (10%) in New Mexico black bears, similar to studies in Florida (0%; Dunbar et al. 1998) and the Pacific Northwest (9%; Mortenson 1998). However, higher prevalences were reported for black bears in Idaho (19%; Binninger et al. 1980) and Alaska (32%; Chomel et al. 1998).

Chomel et al. (1998) also reported that bears seropositive for tularemia were more likely to have seropositive results for brucellosis. Future studies might consider running an additional test for *Brucella* because it has been documented in western black bear populations (Binninger et al. 1980; Dunbar et al. 1998). Only bears <9 yr old were seropositive in Alaska (Chomel et al. 1998), and bears aged 3 and 4 yr old were more likely

to test positive in the Pacific Northwest, US (Mortenson 1998). Of the three seropositive bears in our study, two were 2 and 5 yr old, whereas the third was estimated to be ≥10 yr old. Titer levels in black bears likely vary by year, and prevalence may reflect rabbit and rodent populations that are known to fluctuate in cyclical patterns (Bartel et al. 2008).

West Nile virus

Since it was first discovered in the US in New York City in 1999 (Lanciotti et al. 1999), WNV has been reported in three black bear populations in Eastern US (6%, Farajollahi et al. 2003; 17%, Katz et al. 2007; 8%, Bronson et al. 2014). West Nile virus has not previously been reported in a western black bear population. Although the prevalence detected in our study was low, it warrants further investigation because mortality has resulted from WNV in other wild mammal species, including bats (Chiroptera), squirrels and chipmunks (Sciuridae), and skunks (Mephitidae; Marfin et al. 2001).

Toxoplasma gondii

Toxoplasma gondii infection has been intensively investigated in black bears (e.g., Chomel et al. 1995; Dubey et al. 2014), although most research has occurred in the Eastern US. Chambers et al. (2012) suggested that black bears have one the of greatest seroprevalences of all intermediate hosts, although domestic and wild felids are the only definitive hosts (Hill et al. 2005; Elmore et al. 2010). Home ranges of black bears in this area of New Mexico regularly overlap those of mountain lion (*Puma concolor*) and bobcat (*Lynx rufus*), and black bears have been documented extensively scavenging on carcasses shared by bobcats and mountain lions in our study area. It is possible that scavenging of mountain lion or bobcat kills is the main source of transmission to black bears. Although clinical illness has not been observed in black bears, the congenital sensory and neurologic conditions associated with *T. gondii* in humans can be severe (Fekadu et al. 2010). Thus, close monitoring of infected populations of black bears is justified. Seroprevalence of *T. gondii* in New Mexico black bears was 37%. Higher prevalence has been detected in the central Appalachians (62%; Cox et al. 2017), North Carolina (83%; Nutter et al. 1998), and Pennsylvania (84%; Dubey et al. 2014). Previous reports indicated that older bears, especially males, were more likely to have positive titers for *T. gondii*, presumably because of increased exposure and larger home ranges (Binninger et al. 1980; Nutter et al. 1998). However, Mortenson (1998) reported that 1- and 2-yr-old bears were more likely to have positive titers. In addition, several studies documented a higher prevalence among female bears (Mortenson 1998; Nutter et al. 1998; Bronson et al. 2014). It is unknown which strains are present in western black bears, and future studies might include genotyping isolates.

Tick-borne PCR panel

We detected only one subadult female bear that tested positive for ANAP-EHRL. We found no evidence of exposure to other tick-borne pathogens. Black bears are not known to be a major reservoir for these agents. Skinner et al. (2017) detected antibodies to *Ehrlichia* spp. in 100% and to *Babesia* spp. in 6% of 49 black bears tested in Oklahoma. A few additional studies found several of these agents in black bear populations in Maryland (Bronson et al. 2014), Georgia and Florida (Yabsley et al. 2009), and Oregon and California (Mortenson 1998). These results indicate that black bears in New Mexico are likely exposed, although the prevalence may be low.

Although black bears in north-central New Mexico had antibodies to several pathogens, the presence of antibodies does not necessarily imply they had active infections at the time of sampling. This could indicate a previous infection or that specimens were drawn early in the course of an illness before detectable levels of antibodies had developed. Drawing and testing a second specimen 2–3 wk later may indicate a fourfold change in diagnostic

titers for individuals with acute disease (Gubler et al. 2000). The probability of recapturing and retesting a bear during this period without a focused effort is highly unlikely. Nevertheless, we observed changes in titers for several bears that were incidentally recaptured during the summer and for bears checked in their winter dens. Although the sample size for this study was limited, this information provided new insight into pathogens not otherwise known to exist in black bears of New Mexico.

Wildlife professionals and members of the public contact wildlife through direct handling, human-wildlife conflicts, and secondary exposures through domestic animals (Daszak et al. 2000; Pearce-Duvet 2006; Chomel et al. 2007). Wildlife biologists directly handle wildlife and are often bound procedurally to comply with federal laws, policies, and guidelines for proper animal welfare and acceptable methods of handling (Sikes et al. 2016). Despite precautions, some biologists fail to wear appropriate protective equipment (Wong et al. 2009) and may become complacent after handing a large number of animals. Additionally, animals may not exhibit signs of reduced health, thereby diverting attention from disease transmission risk.

Although the black bear population in north-central New Mexico appears to be relatively stable, the large home ranges of black bears may result in additional interactions with pathogens across the landscape compared with animals with small home ranges. Our results provided novel information for black bears in New Mexico and the Southwest US. This information is important for wildlife management, for monitoring outbreaks, and for public education. It may also provide information for medical treatment in human-bear incidents. Managers may also consider educational programs for safe handling and preparation of bear meat for consumption. We suggest monitoring disease prevalence in black bear populations. Enhanced awareness of zoonotic diseases will help medical practitioners identify etiologies of symptoms. Use of personal protective equipment suggested by the American Society of Mammalogists (Washington, DC, USA; Sikes et al. 2016) is recommended for all biologists and others who handle wildlife. Data from this study provide evidence that black bears in the Jemez Mountains are exposed to a suite of pathogens, although the significance of these agents on population dynamics and transmission is unknown. Therefore, further monitoring is warranted.

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