Survey of Zoonotic Pathogens in White-tailed Deer on Bald Head Island, North Carolina

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Abstract - Odocoileus virginianus (White-tailed Deer) have become overabundant in many urban and suburban areas, which can cause concern about exposure of humans and pets to zoonotic pathogens. Bald Head Island, NC is a small barrier island that has experienced ongoing residential development since the mid-1980s and has a relatively high deer density (15–17 deer/km²). To address concerns expressed by residents, we screened ≈13% of the White-tailed Deer population for potential zoonotic pathogens. We collected blood from 8 deer in January through March 2008 and 5 deer in January 2009. We tested sera for antibodies to Anaplasma phagocytophilum, Borrelia burgdorferi, and six serovars of Leptospira interrogans; and whole blood samples for Bartonella spp. and B. burgdorferi DNA. All sera were negative for antibodies to L. interrogans; two samples were seropositive for A. phagocytophilum, and one was seropositive for B. burgdorferi. Whole blood PCR results were negative for Bartonella spp. and B. burgdorferi. Continued surveillance for wildlife diseases on Bald Head Island is necessary to determine prevalence of specific pathogens, their impacts on the White-tailed Deer population, and the risk of exposure to humans and pets.

Introduction

Odocoileus virginianus Zimmerman (White-tailed Deer; hereafter also “Deer”) are overabundant in many areas throughout their range and can often negatively impact human populations (e.g., property damage, vehicle collisions, exposure to zoonotic pathogens), particularly in suburban areas with expanding residential development (Butfiloski et al. 1997). Epidemiologic surveillance can be useful in identifying and managing zoonotic pathogens, and Deer can serve as effective sentinels for diseases of economic and public health concern (Wolf et al. 2008). Bartonellosis is a constellation of vector-transmitted (e.g., fleas, ticks, flies) bacterial infections caused by Bartonella spp., which have the potential to affect humans and a variety of animals, including Deer (Guptil 2010). Leptospirosis is a bacterial zoonotic disease caused by spirochetes of the genus Leptospira that can be transmitted through urine and tissue of infected carrier animals, and through urine-contaminated water (Alder et al. 2011). Lyme disease and human granulocytotropic anaplasmosis are tick-borne diseases associated, at least indirectly, with

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White-tailed Deer (Dugan et al. 2006, Lane et al. 1991). *Borrelia burgdorferi*, the causative agent of Lyme disease, and *Anaplasma phagocytophilum*, the agent of human granulocytotropic anaplasmosis, have been reported in regions where *Ixodes scapularis* Say (formerly *Ixodes dammini*) (Black-legged Ticks) occur (Dugan et al. 2006, Frank et al. 1998, Magnarelli et al. 2004). White-tailed Deer are important hosts for the adult stage of Black-legged Ticks, and increased Deer density has been shown to increase reproduction and density of these ticks (Magnarelli et al. 2004, Wilson et al. 1985). Additionally, research from Rhode Island noted that barrier islands inhabited by Deer contained spirochete-infected Black-legged Ticks, whereas neither ticks nor pathogens were detected on barrier islands not inhabited by Deer (Anderson et al. 1987). Therefore, increased residential development in areas of high Deer density, especially on barrier islands, could increase exposure of humans and pets to zoonotic pathogens and create a heightened concern among residents (Butfiloski et al. 1997).

Bald Head Island, NC (≈33°51’N, ≈77°59’W) is a 6.2-km² barrier island located at the mouth of the Cape Fear River and is an affluent golf-course community. Residential development began during the 1980s, and by 2009 there were approximately 220 year-round residents on the island; however, each year, the number of visitors to the island may exceed 100,000. By the early 2000s, the number of Deer on Bald Head Island increased to approximately 80 Deer/km². As Deer and human density increased, concerns related to Deer impacts to forested habitat, private property, and public health also increased. In response to public concern, managers began a population-control program (i.e., annual culls) in 2003 to reduce Deer numbers, and by 2008–2009 the estimated Deer population was between 15–17 Deer/km² (Sherrill et al. 2010). Therefore, we examined movements and home ranges of female White-tailed Deer on Bald Head Island and collected blood and serum samples to determine exposure of Deer to specific pathogens that have implications for Deer and human health.

Methods

During January–March 2008 and January 2009, we captured White-tailed Deer using a CO₂-powered dart rifle (Model JM Standard, Dan-Inject, Inc., Børkop, Denmark) or a cartridge-fired dart rifle (Pneu-Dart, Williamsport, PA) to collect blood samples to test for serological evidence of exposure to *B. burgdorferi, A. phagocytophilum*, and *Leptospira interrogans* (serovars *bratislava, canicola, grippotyphosa, hardjo, icterohemorrhagica*, and *pomona*) and for DNA from *Bartonella* spp. and *B. burgdorferi*. We immobilized Deer with an intramuscular injection of 4.4 mg/kg of Telazol® (1:1 tiletamine hydrochloride and zolazepam hydrochloride; Fort Dodge Animal Health, Fort Dodge, IA) and 2.2 mg/kg of XYLA-JECT® (xylazine hydrochloride, Phoenix Pharmaceutical, Inc., St. Joseph, MO) (Kreeger et al. 2002, Sherrill et al. 2010). We collected blood via jugular venipuncture to obtain a minimum of 10 ml to be centrifuged for serum and 6 ml for whole-blood analysis. Serum samples were centrifuged within 30 minutes after collection, and all samples were frozen. Animal-handling methods used in this project were approved by the
Institutional Animal Care and Use Committee (Approval Number 2007-017) at the University of North Carolina at Wilmington and followed guidelines approved by the American Society of Mammalogist (Gannon et al. 2007).

We sent sera to the Connecticut Agricultural Experiment Station to detect total antibodies to strain 2591 and recombinant antigen VlsE1-HIS (VlsE) of *B. burgdorferi*, and separate recombinant protein (p) 44 antigen of *A. phagocytophilum* using a polyvalent enzyme-linked immunosorbent assay (ELISA) (Magnarelli et al. 1999, 2004). Also, indirect fluorescent antibody (IFA) staining methods were used to detect antibodies to strain NCH-1 of *A. phagocytophilum* (Magnarelli et al. 1999). We sent serum samples to the Michigan State University Diagnostic Center for Population and Animal Health to test for agglutinating antibodies against *Leptospira interrogans* (serovars bratislava, canicola, grippotyphosa, hardjo, icterohemorrhagica, and pomona) using a microscopic agglutination test (MAT) (Cole et al. 1973). We sent whole blood samples to North Carolina State University College of Veterinary Medicine to screen for *Bartonella* spp. and *B. burgdorferi* using polymerase chain reaction (PCR) analyses (Diniz et al. 2007, Maggi et al. 2010).

**Results**

In 2008 (*n* = 8), we sampled 1 adult male along with 1 fawn, 1 yearling, and 5 adult females. In 2009 (*n* = 5), we sampled 1 fawn, 1 yearling, and 3 adult females. All test results for *Bartonella* spp. and *L. interrogans* were negative. One adult female in 2009 had an antibody titer of 320 to the p44 recombinant *A. phagocytophilum* antigen. In 2008, the male was seropositive for both the p44 recombinant antigen and strain NCH-1 of *A. phagocytophilum* with antibody titers of 256 and 320, respectively. All PCR results from whole-blood samples were negative for *B. burgdorferi*; however, the male had an antibody titer of 640 for the VlsE-1 recombinant *B. burgdorferi* antigen. All antibody-positive and -negative sera were retested to assess reproducibility of results.

**Discussion**

In this study, we documented that White-tailed Deer on Bald Head Island were exposed to *A. phagocytophilum* and *B. burgdorferi*, which provides valuable information useful in continued disease surveillance. Based on our results, we believe the current risk of human exposure to the select zoonotic pathogens we tested in Deer is probably low. As Deer and/or vector density fluctuates, the vulnerability of wildlife, humans, and pets to various pathogens may change. Bald Head Island has a relatively high Deer density, and changes in Deer density can impact vector populations (e.g., ticks), thereby influencing the risk of exposure of residents and pets to potential zoonotic diseases. Although *Ixodes scapularis* is the primary vector of Lyme disease in much of the eastern United States, *I. affinis* may be more important in the maintenance of enzootic cycles of Lyme borreliosis spirochetes in the coastal regions of the Southeast (Harrison et al. 2010). *Ixodes affinis* is
widely distributed in the coastal plain of North Carolina, and recent research
documented a high incidence of *Borrelia* spp. in *I. affinis* collected in coastal
North Carolina, highlighting the potential importance of *I. affinis* in the main-
tenance of the enzootic transmission cycle of *B. burgdorferi* in this region
(Maggi et al. 2010).

Although this was a small-scale study over a short period, we documented the
exposure of Deer on Bald Head Island to *A. phagocytophilum* and *B. burgdorferi*.
Future research should incorporate increased surveillance of White-tailed Deer,
determine the density of primary vectors of specific pathogens, and provide a
measure of relative risk of zoonotic disease exposure to wildlife, humans, and
pets on Bald Head Island.

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