MANAGING BOVINE TURBERCULOSIS IN WHITE-TAILED DEER IN NORTHWESTERN MINNESOTA: A PROGRESS REPORT

Michelle Carstensen [1], Lou Cornicelli, Michael DonCarlos, and Erika Butler

SUMMARY OF FINDINGS

Bovine tuberculosis (TB) was discovered in 5 cattle operations in northwestern Minnesota in 2005. Two additional cattle herds were found infected in 2006. To date, all of the infected cattle herds have been depopulated and the Board of Animal Health (BAH) has continued an investigation of herds in the area as well as conducted a statewide surveillance effort. The strain has been identified as one that is consistent with bovine TB found in cattle in the southwestern US and Mexico. In November 2006, the Minnesota Department of Natural Resources (DNR) conducted bovine TB surveillance of hunter-harvested white-tailed deer (*Odocoileous virginianus*) within a 15-mile radius of the infected farms. Results indicated that 5 of the 942 deer tested positive for bovine TB; estimated disease prevalence of 0.5% (SE = 0.2%). All infected deer were harvested within 5 miles of Skime, Minnesota, which is in close proximity to 4 of the infected livestock operations. The United States Department of Agriculture (USDA) also required a statewide assessment of bovine TB in wild deer, thus 4,058 additional samples were collected from hunter-harvested deer outside the surveillance zone and tested for the disease; none of these deer were positive for TB. In response to additional deer found infected with bovine TB since 2005, the DNR created a Bovine TB Management Area in northwestern MN to help focus future disease management efforts. Further, a recreational feeding ban, covering 4,000 mi^2 in northwestern MN, was instituted in November 2006 to help reduce the risk of deer to deer transmission of the disease. Also, the Minnesota Legislature passed an initiative that allocated $54,000 for deer-proof fencing materials for livestock producers within 5 miles of a previously infected herd; DNR is currently managing that program. The DNR will continue to conduct hunter-harvested surveillance in fall 2007 to monitor infection in the local deer population, and consider more aggressive management actions (e.g., sharpshooting deer in key locations) to address concerns of deer becoming a potential disease reservoir.

INTRODUCTION

Bovine tuberculosis (TB) is an infectious disease that is caused by the bacterium *Mycobacterium bovis (M. bovis)*. Bovine TB primarily affects cattle, however, other animals may become infected. Bovine TB was discovered in 5 cattle operations in northwestern Minnesota in 2005, and 2 additional herds in 2006. Entering into the fall 2006, 2 wild deer had been found infected with the disease in northwestern MN. Although bovine TB was once relatively common in U.S cattle, it has historically been a very rare disease in wild deer. Prior to 1994, only 8 wild white-tailed and mule deer (*Odocoileus hemionus)* had been reported with bovine TB in North America. In 1995, bovine TB was detected in wild deer in Michigan. Though deer in Michigan do serve as a reservoir of bovine TB, conditions in northwestern Minnesota are different. Minnesota has no history of tuberculosis infection in deer or other wildlife, and the *M. bovis* strain isolated from the infected Minnesota herd does not match that found in Michigan. Also, there are much lower deer densities in the area of the infected herds than in the affected areas of Michigan. Further, unlike Michigan, Minnesota does not allow baiting, which artificially congregates deer and increases the likelihood of disease transmission.

Bovine TB is a progressive, chronic disease, that is spread primarily through the exchange of respiratory secretions between infected and uninfected animals. This transmission usually happens when animals are in close contact with each other. Animals may also become

[1] Corresponding author e-mail: michelle.carstensen@dnr.state.mn.us

infected with bovine TB by ingesting the bacteria from eating contaminated feed. It can take months to years from time of infection to the development of clinical signs. The lymph nodes in the animal's head usually show infection first and as the disease progresses, lesions (yellow or tan, peasized nodules) will begin to develop on the surface of the lungs and chest cavity. In severely infected deer, lesions can usually be found throughout the animal's entire body. Hunters do not always readily recognize small lesions in deer, as they may not be visible when field dressing deer. In fact, most infected deer appear healthy. In Michigan, only 42% of the bovine TB positive deer had lesions in the chest cavity or lungs that would be recognized as unusual by most deer hunters. While it is possible to transmit bovine TB from animals to people, the likelihood is extremely rare. Most human tuberculosis is caused by the bacteria *M. tuberculosis*, which is spread from person to person and rarely infects animals.

METHODS

A surveillance area was developed that encompassed a 15-mile radius around Skime, Salol, and Grygla, Minnesota centering on the locations of the infected livestock operations. A sampling goal was determined to ensure 95% confidence of detecting the disease if prevalent in >1% of the deer population. Given the large geographic area and abundance of deer, the goal was to collect approximately 1,000 samples within the surveillance zone. Additionally, the USDA required a statewide assessment of bovine TB prevalence in 4,000 deer harvested outside of this surveillance zone; thus, registration stations were selected statewide based on deer density and distribution to collect this information (Figure 1). Sampling was conducted during the first 2 weekends of the November 2006 firearms deer hunting season and all samples were voluntarily submitted by hunters.

At the registration stations, hunters were asked to voluntarily submit lymph node (LN) samples for bovine TB testing. Hunter information was recorded, including the hunter's name, address, telephone number, MNDNR number, and location of kill. Maps were provided to assist the hunters in identifying the location (Township, Range, Section, and Quarter-section) of the kill. Cooperating hunters were entered into a gun raffle.

Tissue collection procedures included a visual inspection of the chest cavity of the hunter-killed deer. Six cranial LN's (parotid, submandibular, and retropharyngeal) were visually inspected for presence of lesions and extracted for further testing. Samples were submitted to the Veterinary Diagnostic Laboratory (VDL) at the University of Minnesota for histological examination and acid-fast staining. All samples were then pooled in groups of 5 and sent to the National Veterinary Services Laboratory in Ames, IA for culture. Any suspect carcasses (e.g., obvious lesions in chest cavity or head) were confiscated at the registration stations and the hunter was issued a replacement deer license at no charge. Suspect carcasses were transported in their entirety to the VDL for further testing.

RESULTS AND DISCUSSION

In fall 2006, we collected 5,000 samples from hunter-harvested deer; 4,058 outside and 942 inside the bovine TB surveillance area, respectively (Figure 2). This included 13 whole carcasses that were confiscated from hunters due to the presence of suspicious lesions in the chest cavity or lymph nodes; yielding 4 deer positively infected with bovine TB. An additional positive deer was detected that did not have obvious lesions in the chest cavity, but abscesses were found in the lymph nodes. All infected deer were harvested approximately 5 miles from Skime, Minnesota (Figure 3). No deer sampled through the statewide surveillance effort were found positive for bovine TB outside of the bovine TB surveillance area. The strain of bovine TB from the infected deer matched the strain isolated from the infected cattle herds in the surveillance area and was consistent with bovine TB strains commonly found in the southwestern U.S. and Mexico. The proximity of the infected deer to infected cattle herds, the

strain type, and the fact that disease prevalence (0.5%) is low, supports our theory that this disease spilled-over from cattle to wild deer in this area of the state. However, the increased number of TB-infected deer found this fall, combined with a wider geographic distribution of these infected animals, led the DNR to create a new Bovine TB Management Zone which encompasses a 10-mile buffer around all infected deer discovered to date (Figure 4). Included in this new zone is a core area, which is a 2-mile buffer around all infected deer. This new management zone and its core will help the DNR focus future management actions to help manage the disease in the local deer population.

In November 2006, a ban on recreational feeding of deer and elk was instituted over a 4,000 mi^2 area to help reduce the risk of disease transmission among deer and between deer and livestock (Figure 5). Enforcement officers are planning to conduct an aerial survey of the bovine TB management zone in February 2007 to ensure compliance with the feeding ban.

Further, the Minnesota Legislature passed a $54,000 funding initiative that increased the amount of deer-proof fencing materials that can be provided by the DNR to cattle producers within 5 miles of a bovine TB-infected herd. The intent of this legislation is to protect stored feed from deer depredation and reduce the risk of deer to deer or deer to cattle transmission of the disease. The program allows for up to $5,000 of deer-proof fencing materials per qualified livestock producer.

The presence of bovine TB in cattle and wild deer in Minnesota has led the USDA to demote the state's bovine TB status from "free" to "modified accredited"; resulting in mandatory testing of cattle and restrictions on cattle movements. As part of the requirements to regain TB-Free accreditation, USDA has required BAH to test 1,500 cattle herds statewide for the disease. The DNR is committed to assisting the BAH in regaining Minnesota's TB-Free status. To accomplish this, the DNR will continue to conduct surveillance in 2007 and beyond.

ACKNOWLEDGEMENTS

We would like to thank the students and faculty from the University of Minnesota, College of Veterinary Medicine, that assisted in our sampling efforts. Also, thanks to DNR staff that worked at registration stations, as well as Steve Benson and Julie Adams for making our surveillance maps.

REFERENCES

Minnesota Bovine Tuberculosis Management Plan. 2006. Minnesota Department of Agriculture, Minnesota Department of Natural Resources, Minnesota Board of Animal Health, United States Department of Agriculture, Unpubl. Rept.

Miller, R., J. B. Kaneene, S. D. Fitzgerald, and S.M. Schmitt. 2003. Evaluation of the influence of supplemental feeding of white-tailed deer (Odocoileus virginianus) on the prevalence of bovine tuberculosis in the Michigan wild deer population. Journal of Wildlife Diseases 39: 84-95.

O'brien, D. J., S. D. Fitzgerald, T. J. Lyon, K. L. Butler, J. S. Fierke, K. R. Clarke, S. M. Schmitt, T. M. Cooley, and D. E. Berry. 2001. Tuberculous lesions in free-ranging white-tailed deer in Michigan. Journal of Wildlife Diseases 37: 608-613.

O'brien, D. J., S. M. Schmitt, J. S. Fierke, S. A. Hogle, S. R. Winterstein, T. M. Cooley, W. E. Moritz, K. L. Diegel, S. D. Fitzgerald, D. E. Berry, and J. B. Kaneene. 2002. Epidemiology of Mycobacterium bovis in free-ranging whitetailed deer, Michigan, USA, 1995-2000. Preventive Veterinary Medicine 54: 47-63.

Schmitt, S. M., S. D. Fitzgerald, T. M. Cooley, C. S. Bruning-Fann, L. Sullivan, D. Berry, T. Carlson, R. B. Minnis, J. B. Payeur, and J. Sikarskie. 1997. Bovine tuberculosis in free-ranging white-tailed deer from Michigan. Journal of Wildlife Diseases 33: 749-758.

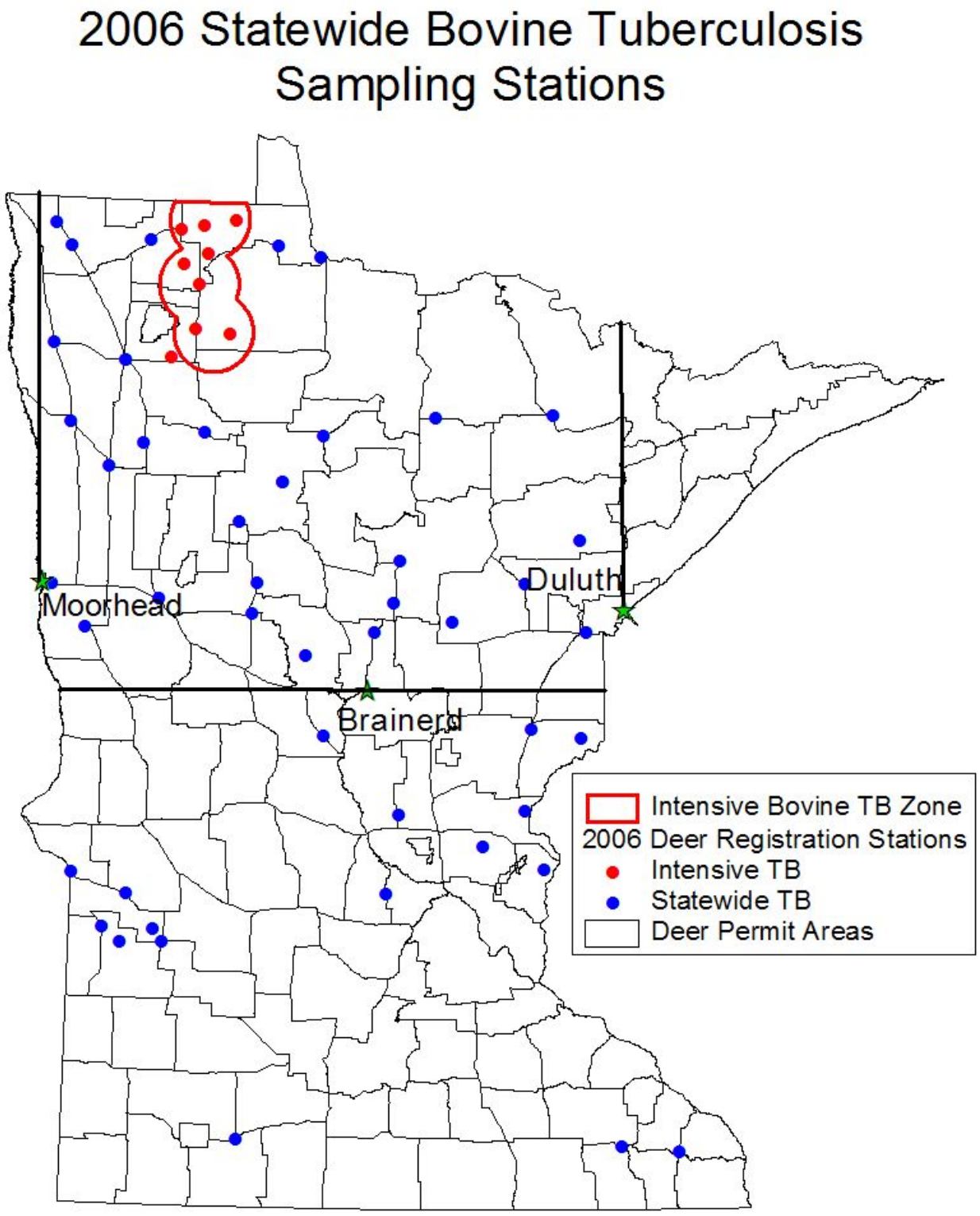


Figure 1. Locations of registration stations to conduct hunter-harvested surveillance of wild deer for bovine tuberculosis in Minnesota, fall 2006.

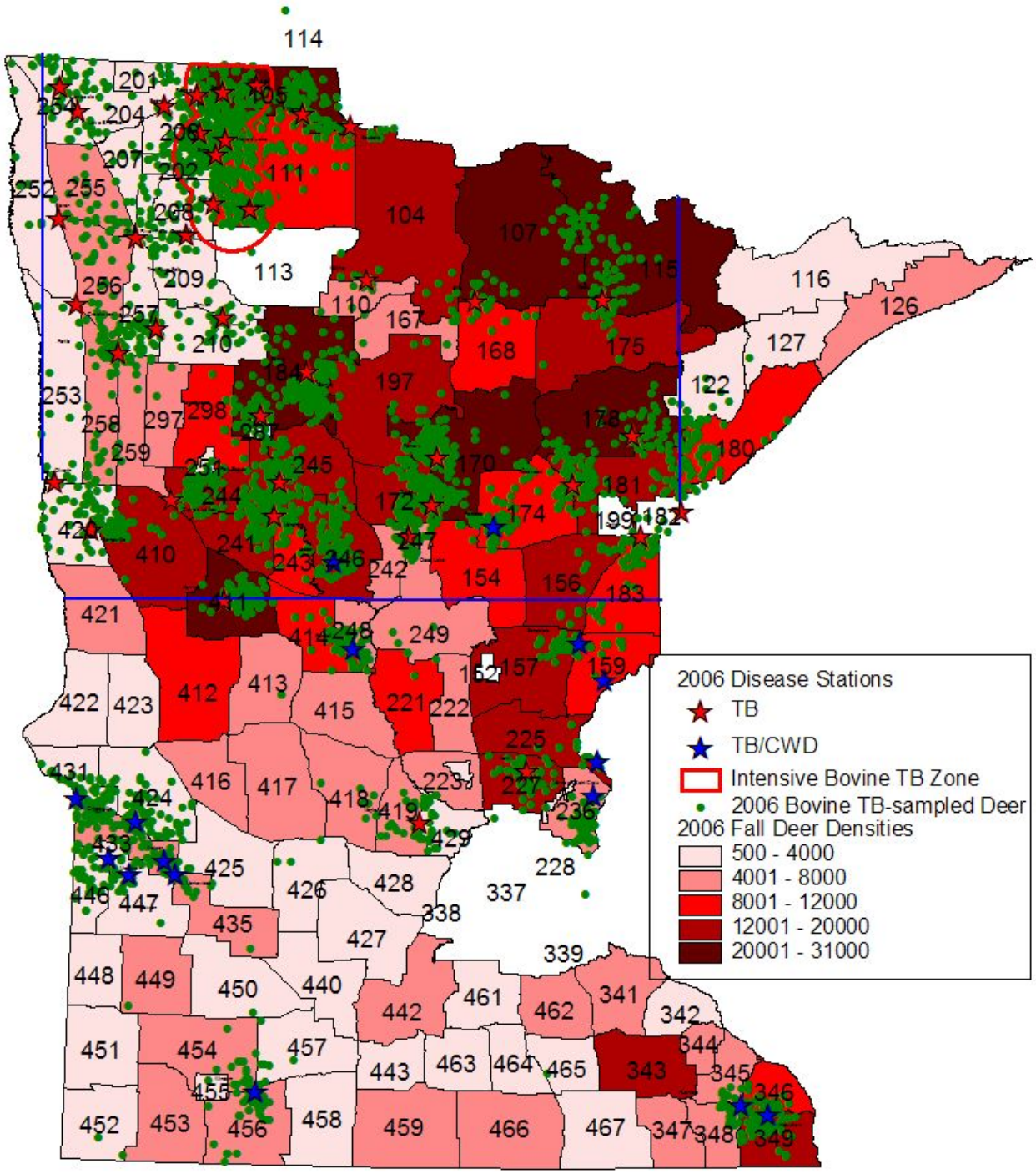


Figure 2. Locations of deer sampled for bovine tuberculosis in Minnesota, fall 2006. Sampling intensity was based on deer densities and distribution within the state.

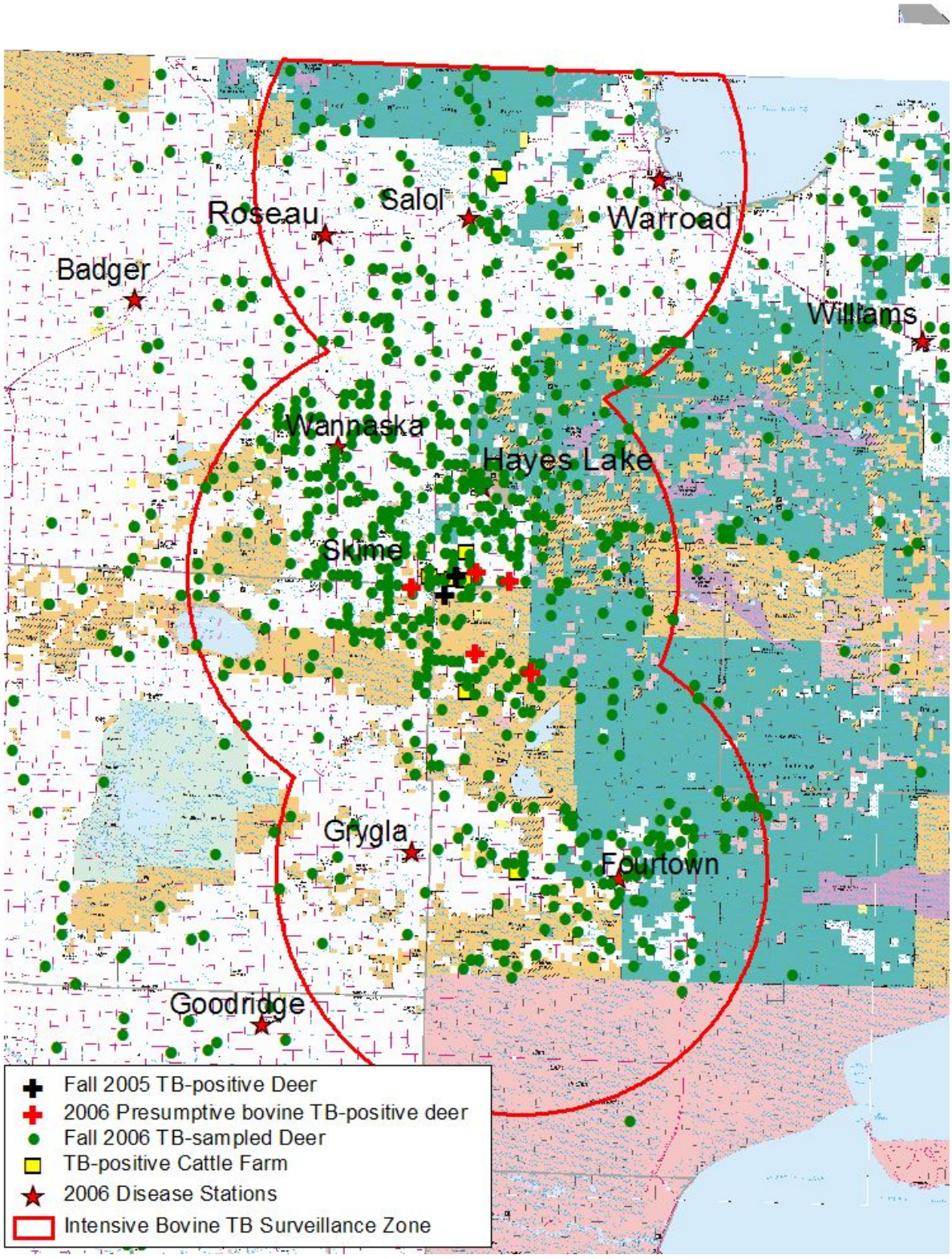


Figure 3. Locations of deer sampled for bovine tuberculosis (TB) in the surveillance zone in northwestern Minnesota, fall 2006. Deer found infected with the disease in 2005 are noted with black crosses, and red crosses correspond to infected deer from 2006.

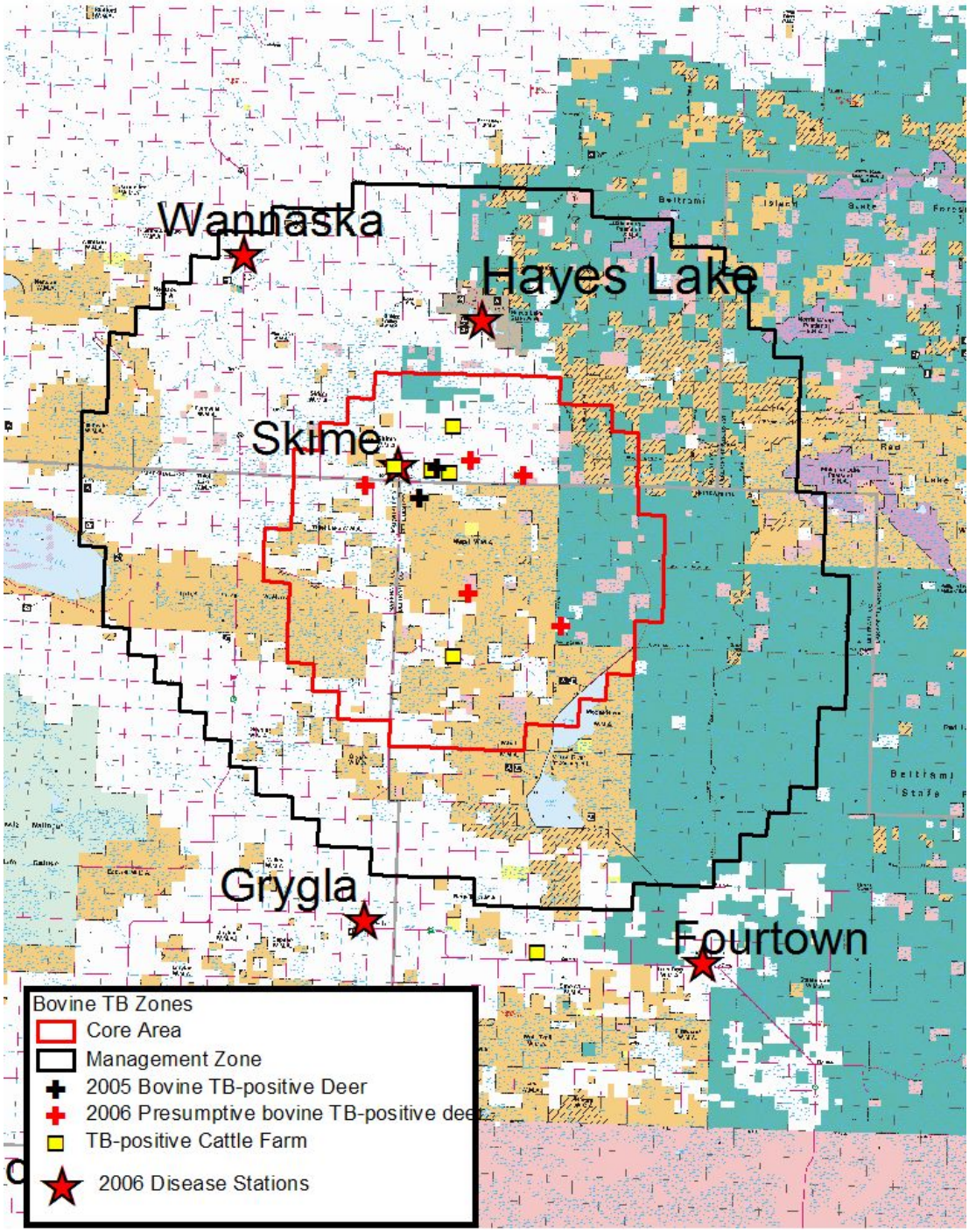
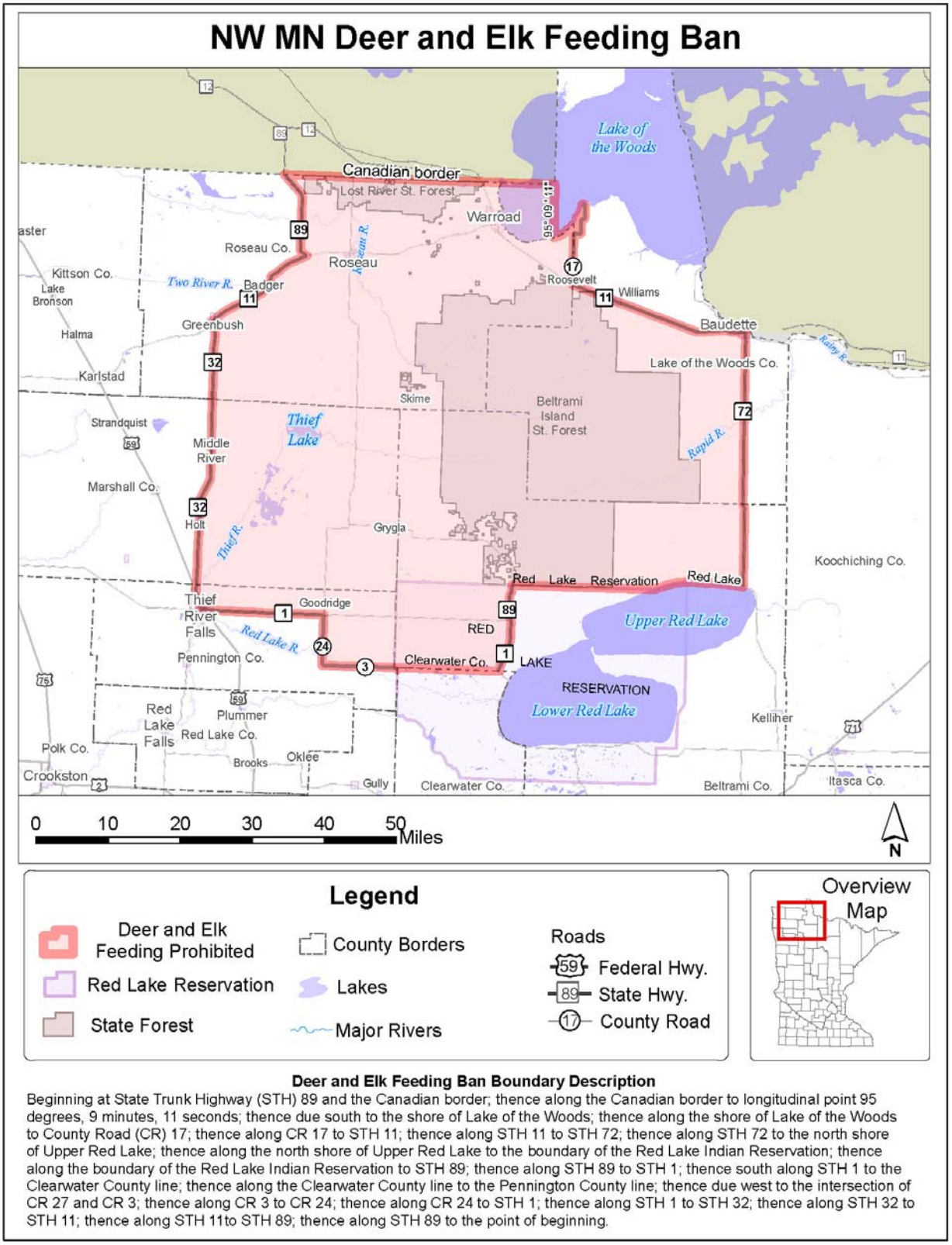


Figure 4. Newly created Bovine Tuberculosis Management Zone (delineated in black), which includes a 10-mile buffer around all deer found positive for the disease and a 2-mile buffered core area (delineated in red). This will allow for increased focus of further disease management efforts for wild deer in northwestern Minnesota.



Deer and Elk Feeding Ban Boundary Description

Beginning at State Trunk Highway (STH) 89 and the Canadian border; thence along the Canadian border to longitudinal point 95 degrees, 9 minutes, 11 seconds; thence due south to the shore of Lake of the Woods; thence along the shore of Lake of the Woods to County Road (CR) 17; thence along CR 17 to STH 11; thence along STH 11 to STH 72; thence along STH 72 to the north shore of Upper Red Lake; thence along the north shore of Upper Red Lake to the boundary of the Red Lake Indian Reservation; thence along the boundary of the Red Lake Indian Reservation to STH 89; thence along STH 89 to STH 1; thence south along STH 1 to the Clearwater County line; thence along the Clearwater County line to the Pennington County line; thence due west to the intersection of CR 27 and CR 3; thence along CR 3 to CR 24; thence along CR 24 to STH 1; thence along STH 1 to STH 32; thence along STH 32 to STH 11; thence along STH 11to STH 89; thence along STH 89 to the point of beginning.

Figure 5. Area in northwestern Minnesota where recreational feeding of deer and elk was banned in November 2006, as a preventative measure to reduce risk of disease transmission.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES CHRONIC WASTING DISEASE SURVEILLANCE PROGRAM 2006

Michelle Carstensen[1], Lou Cornicelli, Michael DonCarlos, and Erika Butler

SUMMARY OF FINDINGS

As a continuation of Minnesota Department of Natural Resources (DNR) surveillance program for Chronic Wasting Disease (CWD), 1,260 free-ranging white-tailed deer (*Odocoileus virginianus*), including 83 exhibiting clinical signs of illness, were screened for the disease in Minnesota. None of these deer were found positive for CWD.

INTRODUCTION

In February 2006, a captive white-tailed deer was diagnosed with CWD in southwestern Minnesota. Consequently, DNR staff flew the immediate area to assess deer population levels, and formulated plans for 2006 surveillance of wild deer in the area to ensure the disease did not spill into the local wild deer herd. The DNR had recently completed statewide surveillance of hunter-harvested deer from 2002–2004, testing approximately 28,000 animals. None were infected with CWD.

CWD is a transmissible spongiform encephalopathy (TSE) that affects elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), white-tailed deer, and moose (*Alces alces*). TSEs are infectious diseases that alter the morphology of the central nervous system, resulting in a "sponge-like" appearance of this tissue. The etiological agent of CWD is believed to be an infectious protein, called a prion. Precise mechanisms and rates of CWD transmission remain unclear, although animal-to-animal contact and environmental contamination are likely to promote the spread of the disease. Incubation time of the disease, from infection to clinical signs, can range from a few months to nearly 3 years. Clinical signs may include a loss of body condition and weight, excessive salivation, ataxia, and behavioral changes. Currently, there is no known treatment for the disease and it is always fatal.

METHODS

At the registration stations, hunters were asked to voluntarily submit retropharyngeal lymph node samples for CWD testing. Samples were submitted to the Veterinary Diagnostic Laboratory at the University of Minnesota for disease screening. Any presumptive positive samples were submitted to the National Veterinary Services Laboratory in Ames, IA for official confirmation of the disease. Hunter information was recorded, including the hunter's name, address, telephone number, MNDNR number, and location of kill. Maps were provided to assist the hunters in identifying the location (township, range, and section) of the kill. Cooperating hunters were entered into a gun raffle.

The DNR continued to sample deer exhibiting clinical symptoms consistent with CWD (targeted surveillance). Information had been disseminated to wildlife staff regarding what to look for regarding symptomatic deer. Staff were given the necessary equipment and training on lymph node removal and data recording. The number of samples expected through targeted surveillance is estimated to be less than 200 animals annually, as few reports of sick deer are received.

During fall 2006, the DNR also collected approximately 4,000 lymph node samples from hunter-harvested deer as part of a one-time, statewide surveillance program for Bovine Tuberculosis. The DNR had planned to screen approximately 1,500 of these samples for CWD

[1] Corresponding author e-mail: michelle.carstensen@dnr.state.mn.us

as well. The registration stations that were selected to screen for both diseases include those along the Minnesota-Wisconsin border and a few central counties where CWD surveillance was conducted in response to CWD-positive captive animals in 2002.

RESULTS AND DISCUSSION

The DNR collected 367 samples from hunter-harvested deer in the vicinity of the positive captive cervid herd and 810 samples from registration stations along the Minnesota-Wisconsin border and central stations (Figure 1). Sampling occurred November 4-12, 2006. All deer tested negative for the disease. Additionally, 83 samples were submitted from suspect deer statewide through targeted surveillance; all deer tested negative for the disease.

Since the agency has now collected approximately 30,000 negative samples in statewide surveillance efforts, we feel that future resources for CWD surveillance, in addition to targeted surveillance, are better spent addressing changing risk factors. Specifically, it is important to monitor the CWD surveillance activities occurring in our bordering states, and conduct periodic surveillance in Minnesota in response to CWD status changes in these states. Additionally, periodic surveillance in the vicinity of previous cases of CWD in captive cervids in Minnesota may be prudent. Targeted surveillance of suspect deer is expected to continue throughout the State.

ACKNOWLEDGEMENTS

We would like to thank the students and faculty from the University of Minnesota, College of Veterinary Medicine, that assisted in our sampling efforts. Also, thanks to DNR staff that worked at registration stations, as well as Steve Benson and Julie Adams for making our surveillance maps.

REFERENCES

Miller, M.W., E.S. Williams, N.T. Hobbs, and L.L. Wolfe. 2004. Environmental sources of prion transmission in mule deer. Emerg. Infec. Dis. Available from http://www.cdc.gov/ncidod/EID/vol10no6/04-0010.htm.

Miller, M.W., E. S. Williams, C. W. McCarty, T. R. Spraker, T. J. Kreeger, C. T. Larsen, and E. T. Thorne. 2000. Epizootiology of chronic wasting disease in free-ranging cervids in Colorado and Wyoming. Journal of Wildlife Diseases 36: 676-690.

Spraker, T. R., M. W. Miller, E. S. Williams, D. M. Getzy, W. J. Adrian, G. G. Schoonveld, R. A. Spowart, K. I. O'Rourke, J. M. Miller, and P. A. Merz. 1997. Spongiform encephalopathy in free-ranging mule deer (Odocoileus hemionus), white-tailed deer (*Odocoileus virginianus*) and Rocky Mountain elk (Cervus elaphus nelsoni) in northcentral Colorado. Journal of Wildlife Diseases 33: 1-6.

Williams, E.S., and S. Young. 1993. Neuropathology of chronic wasting disease of mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus nelsoni*). Veterinary Pathology 30: 36-45.

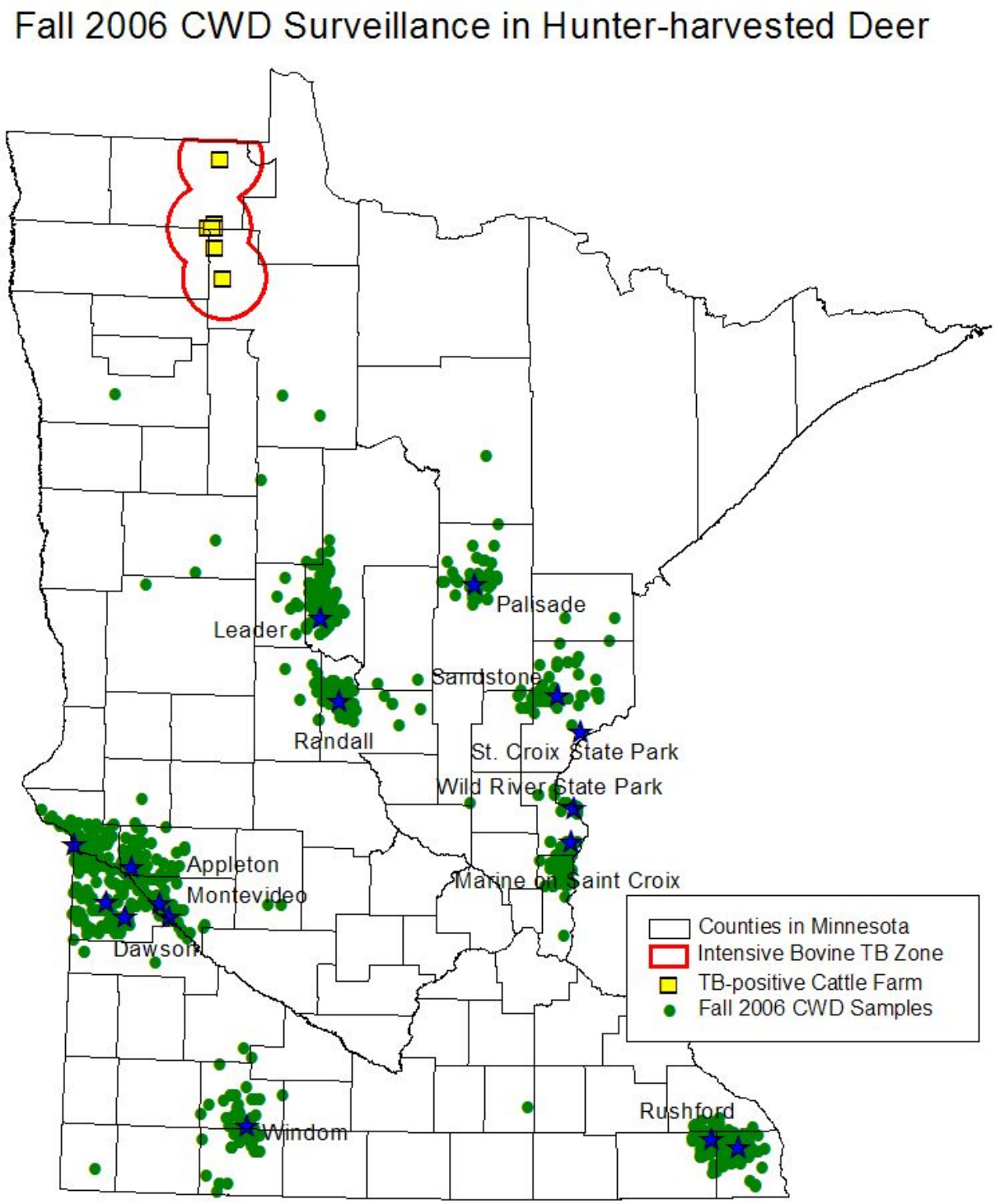


Figure 1. Sampling distribution for hunter-harvested deer tested for chronic wasting disease in Minnesota, fall 2006.

SURVEILLANCE FOR HIGHLY PATHOGENIC AVIAN INFLUENZA IN MINNESOTA'S WATERFOWL

Michelle Carstensen[1] and Michael DonCarlos

SUMMARY OF FINDINGS

As part of a national strategy for early detection of highly pathogenic avian influenza (HPAI) in North America, the Minnesota Department of Natural Resources (DNR) and the United States Department of Agriculture Wildlife Services (USDA-WS) conducted surveillance for the virus in waterfowl in the State. A combined total of 2,065 birds were sampled for HPAI in Minnesota during 2006. Testing did not result in any positive cases of HPAI, specifically the Asian strain of subtype H5N1; however 1 Northern pintail *(Anas acuta*) and 1 ring-necked duck (*Aythya collaris*) did test positive for a low pathogenic strain of avian influenza (AI) with the subtype H5, and 1 American green-winged teal (*Anas crecca*) tested positive for an N1 subtype. Approximately 164,000 wild birds were sampled throughout the United States in 2006, and no positive cases of HPAI were detected. It is likely that the DNR will continue surveillance for the virus in the state's waterfowl for the next several years, in cooperation with the Mississippi Flyway, Council of the US Fish and Wildlife Service, and the USDA.

INTRODUCTION

Recent worldwide attention on the spread of a highly pathogenic strain of avian influenza (HPAI), subtype H5N1, from Asia to Europe and Africa in 2006 has led to the development of a coordinated National Strategic Plan for early detection of HPAI-H5N1 introduction into North America by wild birds. Although movements of domestic poultry or contaminated poultry products, both legally and illegally, are believed to be the major driving force in the spread of HPAI-H5N1, migratory birds are thought to be a contributing factor.

This national plan outlined a surveillance strategy that targeted sampling of wild birds species in North America that have the highest risk of being exposed to or infected with HPAI-H5N1 because of their migratory movement patterns. Currently, these include birds that migrate directly between Asia and North America, birds that may be in contact with species from areas in Asia with reported outbreaks, or birds that are known to be reservoirs of AI. A step-down plan was developed by the Mississippi Flyway Council in 2006 identifying Minnesota as a key flyway state needed to participate in regional sampling for early detection of HPAI-H5N1 in migratory ducks, geese, and shorebirds.

In June 2006, the DNR entered into a $100,000 cooperative agreement with the USDA-WS to sample 1,000 wild birds (either live-caught or hunter-harvested) in Minnesota for HPAI-H5N1 during 2006. In addition to the 1,000 samples to be collected by DNR, USDA-WS was also planning to collect a similar number of samples in the State during the same period. Bird species that were targeted include those listed as priority species in the National Strategic Plan or approved for sampling in Minnesota by the Mississippi Flyway Council.

Avian influenza is a viral infection that occurs naturally in wild birds, especially waterfowl, gulls, and shorebirds. Avian influenza is caused by type A influenza viruses that have 2 important surface antigens, hemagglutinin (H) and nuraminidase (N), that give rise to 144 possible virus subtypes. Influenza viruses vary widely in pathogenicity and ability to spread among birds. The emergence of an Asian strain HP-H5N1 virus in 1996 and subsequent spread of the virus in Asia, Africa, and Europe has killed thousands of wild birds and millions of domestic poultry. In 1997, HP-H5N1 became zoonotic in Hong Kong and to-date has infected at least 200 humans in Eurasia and Africa, resulting in over 100 deaths.

[1] Corresponding author e-mail: michelle.carstensen@dnr.state.mn.us

METHODS

DNR planned to sample 100 common goldeneye (*Bucephala clangula*) and 100 ring-necked ducks during the summer months, primarily in conjunction with planned banding activities, and 100 Northern pintails, 200 mallards (*Anas platyrhynchos*), 200 American green-winged teal, 100 lesser scaup (*Aythya affinis*), and 200 Canada geese (*Branta canadensis*) in the fall through hunter-harvested surveillance. USDA-WS planned to sample 100 mallards, 50 Canada geese, and 100 shorebirds during the summer months, and 100 Northern pintails, 100 lesser scaup, 100 common goldeneyes, 100 ring-necked ducks, 100 American blue-winged teal (*Anas discors*), 100 shorebirds, 100 sharp-shinned hawks (*Accipiter striatus*), and 100 gray-cheeked thrush *(Catharus minimus*) during the fall. If sampling goals per species could not be met, other targeted waterfowl species, such as American wigeon (*Anas americana*) or Northern shovelers (*Anas clypeata*), could be substituted to ensure that total numerical sampling goals were met. Sampling strategies were coordinated between DNR and USDA-WS to maximize access to targeted birds species through existing banding operations and fall hunter-harvested surveillance.

Cloacal swabs were used to collect samples and they were submitted to the Veterinary Diagnostic Laboratory in St. Paul, MN for initial screening for the virus. If positive for avian influenza virus, samples were forwarded to the National Veterinary Services Laboratory in Ames, IA for strain-typing.

RESULTS AND DISCUSSION

DNR collected a total of 1,015 samples; 24% in the summer through banding programs and 74% in fall through hunter-harvested surveillance. USDA-WS collected a total of 1,050 samples; 33% in the summer months and 67% in the fall. Thus, a combined total of 2,065 birds were sampled for HPAI-H5N1 in Minnesota in 2006 (Figures 1 and 2, Table 1).

Testing did not result in any positive cases of HPAI-H5N1; however 1 Northern pintail and 1 ring-necked duck did test positive for a low pathogenic strain of avian influenza with the subtype H5, and 1 American green-winged teal tested positive for an N1 subtype (Table 1). The testing protocol was limited to the screening for H5, H7, and N1 subtypes only.

According to the latest numbers on the United States Geologic Survey's website (http://wildlifedisease.nbii.gov/ai/), approximately 164,000 birds have been sampled for HPAI-H5N1 in the U.S. in 2006. This includes over 22,000 samples taken in Alaska, which was considered the most at-risk state for the introduction of HPAI-H5N1 into North America. No positive cases of HPAI-H5N1 have been found anywhere in North American to date. However, the National Veterinary Services Laboratory did report 16 presumptive positive H5N1 cases, of which only 6 were confirmed as a low pathogenic H5N1 subtypes (commonly referred to as the "North American Strain"). These 6 cases included: American green-winged teal (Delaware), mallard (Illinois), mallard (Michigan), mallard (Pennsylvania), mute swan (*Cygnus olor*) (Michigan), and a mallard (Maryland).

Surveillance for HPAI-H5N1 will likely continue in Minnesota, and other parts of the U.S. for the next several years. The USDA has banked all samples taken in 2006 and is currently accepting proposals from state agencies and universities for further avian influenza research. Minnesota remains prepared to assist with future surveillance objective if needed. In addition, the DNR has developed a surveillance and response plan for HPAI in wild birds, which includes increased vigilance of mortality and morbidity events within the State.

ACKNOWLEDGEMENTS

This project would not have been possible without the valuable contribution of the waterfowl research group, including Jeff Lawrence, Steve Cordts, and Jim Berdeen (and Jim's

group of banding interns). Other DNR staff that provided valuable assistance to this project included Erika Butler, Joel Huener, Marshall Deters, Stan Wood, Perry Leogering, Joel Anderson, Dave Trauba, Kevin Kotts, and Blane Klemek. I would also like to recognize our USDA-WS partners on the project, Barb Bodenstein and Pete Sahr for their efforts to ensure that we met our overall sampling goals.

REFERENCES

Halvorson, D.A., C. J. Kelleher, and D. A. Senne. 1985. Epizootiology of avian influenza: effect of season on incidence in sentinel ducks and domestic turkeys in Minnesota. Applied and Environmental Microbiology 49: 914-919.

Hanson, B. A., D. E. Stallknecht, D.E. Swayne, L. A. Lewis, and D. A. Senne. 2003. Avian influenza viruses in Minnesota ducks during 1998-2000. Avian Diseases 47: 867-871.

Interagency Asian H5N1 Early Detection Working Group. 2006. An early detection system for Asian H5N1 highly pathogenic avian influenza in wild migratory birds: U.S. Interagency Strategic Plan. Unpubl. Rept. Report to the Department of Homeland Security, Policy Coordinating Committee for Pandemic Influenza Preparedness.

Michigan Department of Natural Resources, Wildlife Division. 2006. Michigan surveillance and response plan for highly pathogenic avian influenza in free-ranging wildlife. Unpubl. Rept.

Mississippi Flyway Council. 2006. Surveillance for early detection of highly pathogenic avian influenza H5N1 in wild migratory birds: a strategy for the Mississippi Flyway. Unpubl. Rept.

Table 1. Bird species sampled for highly pathogenic avian influenza H5N1 by Minnesota Department of Natural Resources and United States Department of Agriculture-Wildlife Services in 2006.

Species sampled	*n*	***Sex***[a]	***Age class***[b]	***Results of Avian Influenza testing***
Ducks				
American Green-winged Teal	248	39%F, 54%M, 7%U	43%J, 49%A, 8%U	H?N1 (Marsh Lake)
American Wigeon	99	38%F, 56%M, 6%U	63%J, 32%A, 5%U	Negative
American Blue-winged Teal	244	46%F, 32%M, 22%U	50%J, 32%A, 18%U	Negative
Common Goldeneye	86	42%F, 58%M	100%J	Negative
Gadwall	4	25%F, 50%M, 25%U	50%J, 25%A, 25%U	Negative
Lesser Scaup	30	47%F, 37%M, 16%U	37%J, 47%A, 16%U	Negative
Mallard	310	51%F, 46%M, 3%U	82%J, 15%A, 3%U	H4N6 and H?N2 (Thief Lake WMA)
Northern Pintail	111	59%F, 39%M, 2%U	71%J, 25%A, 4%U	H5N? (Thief Lake WMA)
Northern Shoveler	75	49%F, 47%M, 4%U	63%J, 35%A, 2%U	Negative
Redhead	19	26%F, 32%M, 42%U	16%J, 42%A, 42%U	Negative
Ring-necked Duck	330	43%F, 36%M, 21%U	48%J, 30%A, 22%U	H5N? (Upper Rice Lake)
Wood duck	1	Not determined	Not determined	Negative
Canada Geese	151	25%F, 19%M, 56%U	38%J, 56%A, 6%U	Negative
Shorebirds				
Bairds Sandpiper	4	Not determined	Not determined	Negative
Greater Yellowlegs	3	Not determined	Not determined	Negative
Least Sandpiper	98	Not determined	Not determined	Negative
Lesser Yellowlegs	8	Not determined	Not determined	Negative
Pectoral Sandpiper	31	Not determined	Not determined	Negative
Short-billed Dowitcher	3	Not determined	Not determined	Negative
Semipalmated Plover	2	Not determined	Not determined	Negative
Semipalmated Sandpiper	52	Not determined	Not determined	Negative
Spotted Sandpiper	2	Not determined	Not determined	Negative
Upland Sandpiper	2	Not determined	Not determined	Negative
Wilson's Snipe	1	Not determined	Not determined	Negative
Other				
Gray-cheeked Thrush	8	Not determined	Not determined	Negative
Swainson's Thrush	3	Not determined	Not determined	Negative
Sharp-shinned Hawk	140	47%F, 52%M, 1%U	91%J, 8%A, 1%U	Negative
Total	2065			

[a]F=female, M=male, U=unknown.
[b]J=juvenile, A=adult, U=unknown.

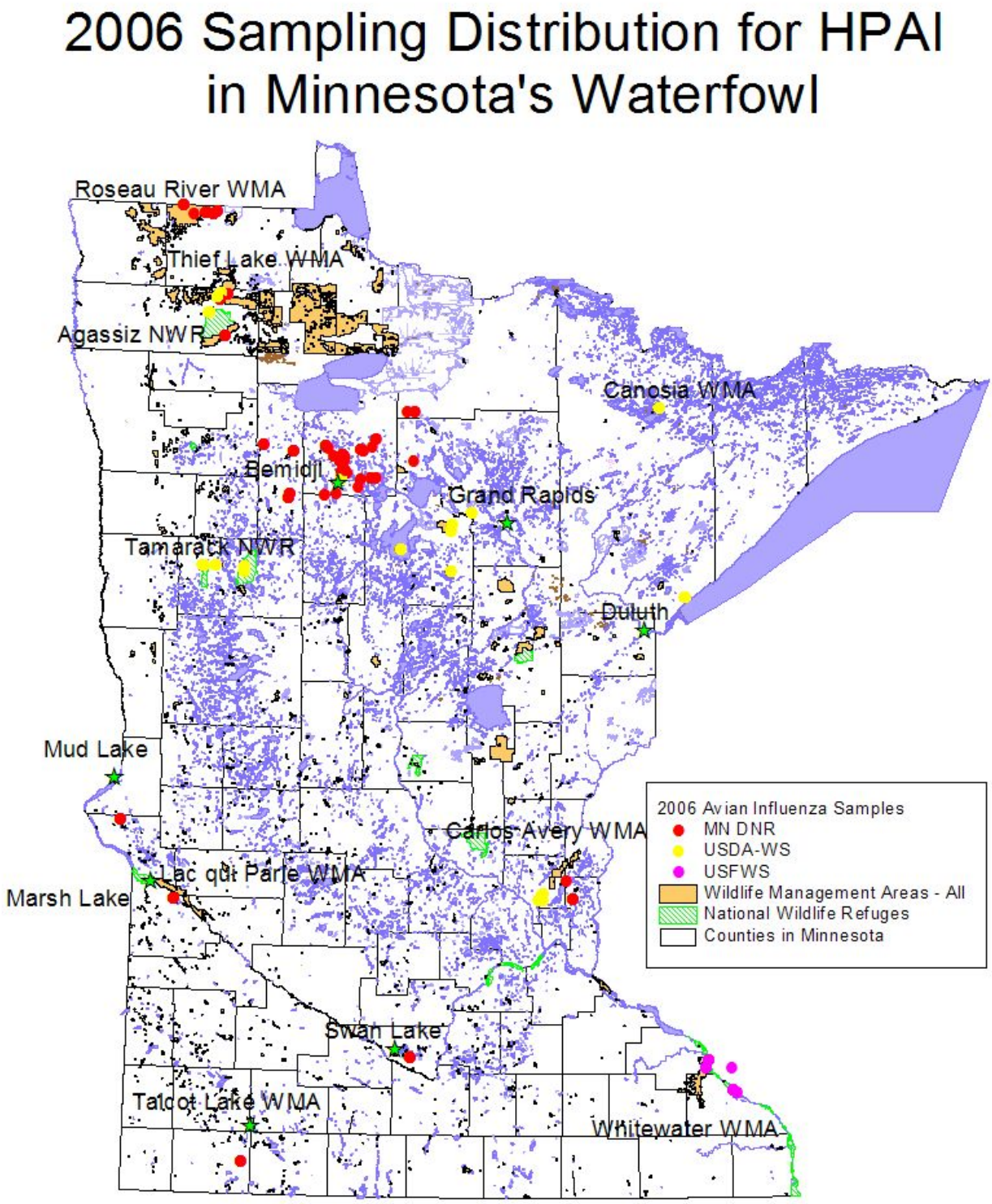


Figure 1. Sampling locations where waterfowl were tested for highly pathogenic avian influenza in Minnesota during 2006.

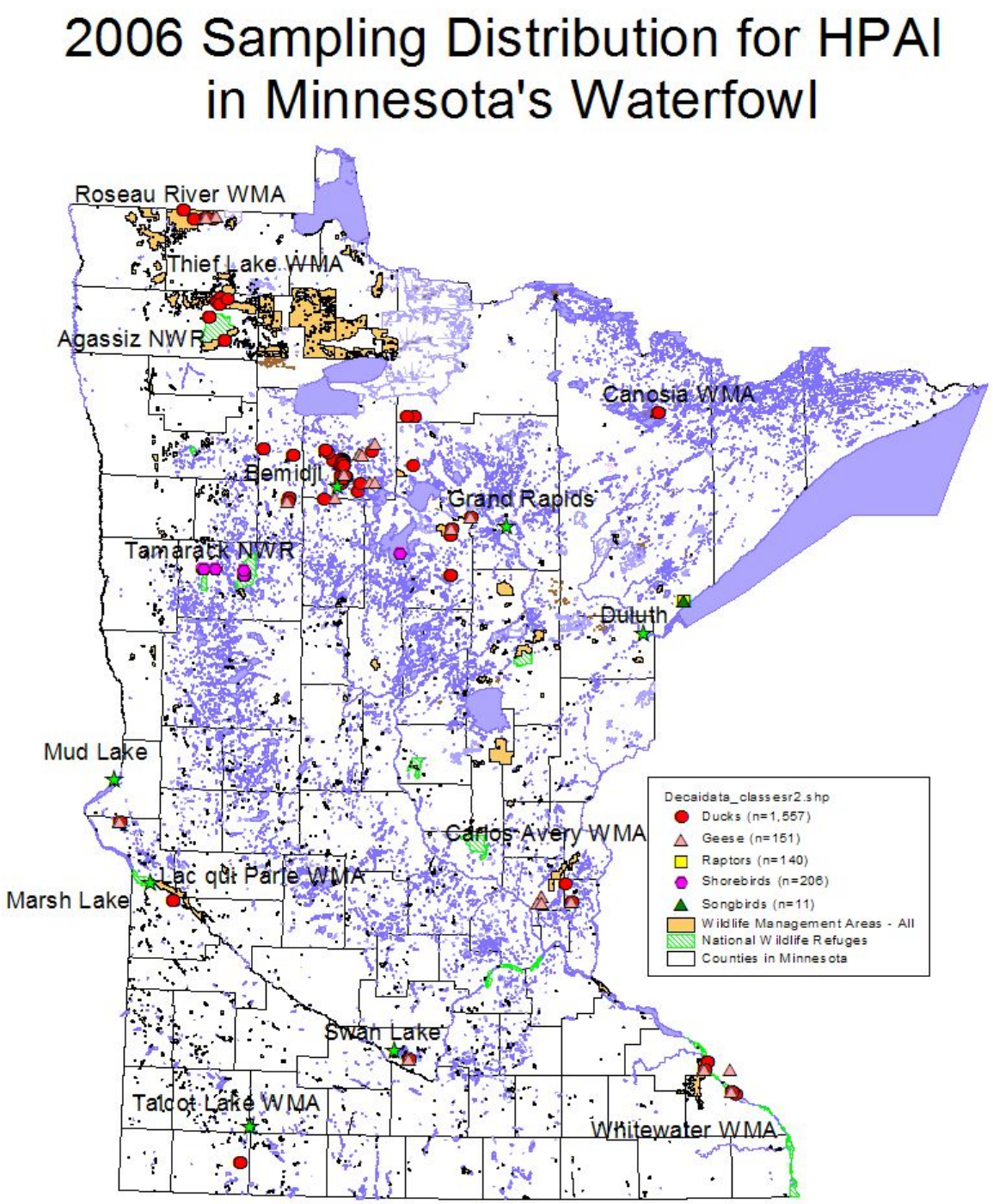


Figure 2. Distribution of waterfowl, including ducks, geese, raptors, shorebirds, and songbirds sampled for highly pathogenic avian influenza in Minnesota during 2006.