National Wildlife Disease Program

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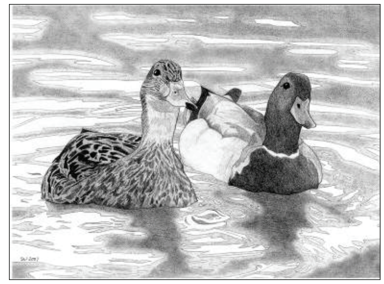

INSIDE THIS ISSUE:

COORDINATOR COMMENTARY

By Dr. Thomas DeLiberto

The problems of our global society are increasingly complex and interdependent, and consequently, are not isolated to particular groups or disciplines. They are unpredictable, emergent phenomena with nonlinear dynamics whose effects have positive and negative feedbacks. As the problems develop, and strategies to address them are implemented, uncertainties continue to emerge, and unexpected results occur requiring not only a re-evaluation of one's strategies, but also of the problem itself. Many of the environmental problems we face today are characterized by such complexity. Issues such as climate change, maintenance of biodiversity, pollution, and emerging infectious diseases are not only biologically complex, but are technically and socially complex on a global scale. Traditional, intradisciplinary approaches of science are incapable of addressing complex environmental and health problems that transcend scientific, social, and technologic fields of study. A new approach to these complex problems is required.

By their very nature, complex problems require the collaboration of numerous groups of scientists, decision makers, and stakeholders to develop and implement solutions. Collaborations should foster an integrated approach to addressing conservation, social, economic, and political factors. This principle is embodied within the One Health approach to medicine, which recognizes that the physical, psychological, and social health of people are inextricably linked with animal and ecosystem health.

A transdisciplinary approach is needed to ground complex issues in their ecological and social context, and enable decision makers to reach across agencies and disciplines to work with counterparts in conservation, medicine, agriculture, education, economics, and planning, to strengthen the basis for sustainable ecosystems, health, and development policies. Transdisciplinarity recognizes that complex problems are open and ill-defined, and that the reality being investigated consists of a nexus of phenomena which are not reducible to a single dimension.

One Health issues are global and complex. As such, they require international collaboration if we hope to achieve the goal of minimizing impacts of disease on humans and animals, while maintaining biodiversity and ecosystem integrity. This will require motivated teams to overcome barriers to collaboration, by focusing on the proven keys to success and developing networks of biological, physical, and social scientists as well as decision makers and stakeholders. These collaborations will require facilitation by governments and international organizations.

Finally, we must move towards a more holistic, transdisciplinary approach to international collaborations. New forms of knowledge, institutional structure, and problem solving require a new dialogue of science and humanities. Transdisciplinarity serves to ground the particular emerging disease issue in its ecological, social and health context, and enable decision makers to cross agency boundaries to strengthen the basis for sustainable ecosystems, health, and development policies. The future successes in addressing complex issues such as emerging infectious diseases, loss of biodiversity, and climate change will depend on collaborations based on transdisciplinarity.

NWDP

The wildlife drawings on this page are original artworks created by the National Wildlife Disease Program's former Administrative Support Assistant Erika Kampe (prairie dog) and Wildlife Technician Sarah Goff (ducks).

Volunteers Expand Wildlife Disease Surveillance In Indiana

By Joe Caudell

The Indiana Wildlife Disease Surveillance Network is a cooperative volunteer program managed by the NWDP. Partners include the Indiana Department of Natural Resources, Indiana Board of Animal Health, Indiana State Department of Health, and the nuisance wildlife control operators in the state. The purpose of the group is to expand the wildlife disease surveillance capability of state and federal agencies in Indiana. Wildlife Services in Indiana has only a few field employees working in limited areas of the state. Therefore, getting samples for routine disease surveillance has been challenging. The program relies on individuals who have close contact with wildlife and are willing to donate a small amount of their time for training and surveillance activities. Currently, volunteers primarily consist of nuisance wildlife control operators and a few other state and federal employees who work with wildlife. Future plans are to expand the organization to include wildlife rehabilitation professionals, and others who work with wildlife in a professional capacity. Currently, the Indiana Wildlife Disease Surveillance Network collects samples for tularemia and other pathogens that can be detected through serology, provides reports of unusual bat activity for white-nose syndrome surveillance, and develops information about feral swine sightings. Future projects include conducting routine surveillance for distemper in raccoons (Procyon lotor) using nobuto strips.

The cost of the program has been minimal while the benefits have been great. Sampling supplies, and personal protective equipment, are provided by the cooperator, while shipping is often paid for by Wildlife Services. All cooperating entities receive results and share authorship of publications and presentations. Occasionally, members receive hats or other gear to encourage participation, and recognition is given to the individuals with the greatest participation.

This partnership has not only been beneficial for disease surveillance, but it has enhanced the relationship between Wildlife Services in Indiana and the nuisance wildlife control operators. Wildlife Services provides routine updates at the bi-annual nuisance wildlife control operators meetings, gives lectures on wildlife diseases, includes the Indiana Wildlife Disease Surveillance Network in the mail list of the Indiana Wildlife Disease News, and has presented at the 1st Annual Nuisance Wildlife Control Operators Association meeting.

Collaborative Surveillance for Eastern Equine Encephalitis

By Kirk Shively and Charles Lubelczyk

Wildlife disease biologist Kirk Shively drawing blood from a wild turkey (*Photo: Kirk Shively*)

Eastern equine encephalitis (EEE) virus is a mosquito-borne Alphavirus that can cause disease in horses, deer, and humans. Birds serve as the primary reservoirs for EEE. The virus is transmitted by mosquitoes, especially *Culiseta* species which prefer to feed on birds. Other mosquito species of the genera *Culex, Aedes*, and *Coquillettidia*, which feed on birds and mammals, serve as bridge vectors for viral transmission. Human cases of disease have been sporadic across much of the eastern and midwestern United States, with serious morbidity and frequent long-term complications resulting from infection. Avian mortality has been noted in some passerines, game birds, and shore birds.

The distribution of the EEE virus in Maine is largely unknown. The virus was first detected in southern Maine in 2001 when an American goldfinch (*Carduelis tristis*) submitted in conjunction with West Nile virus surveillance tested positive for EEE virus. Subsequent cases of EEE in southern Maine were reported in 2005; twelve birds and two horses from York and Cumberland counties submitted to the Maine Health and Environmental Testing Laboratory tested positive for the virus. A smaller number of birds tested positive in 2006, and in 2007, EEE virus was detected only in a pool of *Culiseta inornata*

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(*EEE, Continued from page 2)*

collected in York County. In 2008 there was a recurrence of the virus in a horse and a lone mosquito pool of *C. melanura* from York County. Later that year, a Massachusetts resident was diagnosed with EEE and the time of onset suggested possible exposure in either Maine or New Hampshire, although there was no confirmation of where the virus was acquired.

Wildlife disease biologist Kirk Shively sampling for EEE virus from a wild turkey (*Photo: Kirk Shively)*

From July to October, 2009, an unprecedented epizootic of EEE virus occurred in several counties in southern and central Maine. Maine Department of Agriculture reported 16 potential ungulate livestock mortalities (15 horses, 1 llama), 13 of which were confirmed positive for EEE. In addition, the Maine Department of Inland Fisheries and Wildlife reported substantial mortality in three ring-necked pheasant (*Phasianus colchicus*) flocks that were confirmed positive for the disease. One wild turkey (*Meleagris gallopavo*) captured in January 2010 was sero-positive for EEE virus. No human cases were reported during this period.

A rocket net deployed over wild turkeys (*Photo: Kirk Shively)*

In an effort to increase understanding of the epidemiology of EEE virus, Wildlife Services has been collaborating with state and federal partners to conduct surveillance in wild birds since 2009. The European starling (*Sturnus vulgaris)* was selected as a primary target species for surveillance because these birds have close association with livestock and people, and laboratory experiments indicated that starlings were competent carriers and shedders of the virus. Starlings were captured from farms in three separate counties. Of 101 birds sampled for EEE, none have tested positive for the virus.

Wildlife disease biologist Kirk Shively taking a bird from the net to the processing area (*Photo: Kirk Shively)*

Wild turkeys and white-tailed deer (*Odocoileus virginianus*) are also being opportunistically sampled. Maine Medical Center Research Institute, in conjunction with Centers for Disease Control and Prevention, Maine Department of Inland Fisheries and Wildlife, and Wildlife Services, sampled and tested hunter-harvested deer from six counties in 2009 and 2010. Over 8 percent of deer tested were positive for EEE antibodies.

During 2011, Wildlife Services is continuing to collaborate with these partners on EEE surveillance. Sera from wild turkeys captured over the last several months, and wild turkeys harvested by hunters next fall, will be tested for the presence of EEE virus and antibodies.

This project will provide important information on the role of wildlife species in the epidemiology of EEE virus in Maine.

Teaming up Against Toxoplasmosis

By John Baroch, David Sinnett, and Todd Felix

Toxoplasmosis can be a serious disease in humans, affecting the developing fetus of women who acquire infection during pregnancy, and individuals who are immunocompromised as a result of HIV-1 infection, lymphoma or immunosuppressive therapy. The causative agent is *Toxoplasma gondii,* a protozoan parasite with worldwide distribution. Humans can become infected with *T. gondii* by consuming undercooked meat carrying tissue cysts, or accidental ingestion of encysted eggs (oocysts) from the environment, which are shed in the feces of felids (the cat family, Felidae). About 12% of the U.S. population is thought to be infected with *T. gondii* and approximately 20% of U.S. deaths attributed to food-borne pathogens are due to *T. gondii* infection. Infection in healthy adults is controlled by the immune system, and rarely causes disease.

The incidence of *T. gondii* in enclosure-reared livestock, including swine, in the U.S. is quite low due to improved animal husbandry practices. However, *T. gondii* infection can be more common in free-ranging and backyard livestock. Most healthy livestock are resistant to clinical toxoplasmosis, but infections during pregnancy can cause abortions.

Like humans and most livestock, wild animals are usually resistant to clinical toxoplasmosis. Notable exceptions include marine mammals and Australian macropods, many of which are highly susceptible. Infection with *T. gondii* in wildlife is common,

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DEVELOPING BIOSENSORS FOR DISEASE DETECTION

By Dennis Kohler and Bruce Kimball

Healthy animals have unique "odortypes" or patterns of volatile chemical signatures associated with their, breath, urine, feces, and other secretions. When a virus or bacteria infects an animal, physiological processes to fight off the agent are initiated. Metabolic changes that accompany these processes result in alterations of the animal's odor profile. It also has been speculated that certain pathogens themselves might be associated with distinctive odors. The mechanisms underlying changes in body odor caused by disease are poorly understood, but they likely involve alteration of immune function, which is known to be innately related to body odor composition.

Literature on the influence of disease on body odor exists, and there are credible reports of dogs detecting human malignancies. For example, mice infected with mammary tumor retrovirus incur a unique odor prior to the development of tumors. Studies also have demonstrated that infected animals are recognized by members of the same species through alteration of

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(Toxoplasmosis, Continued from page 3)

and in some species infection rates can be quite high. *T. gondii* infection in wildlife species can be a source of infection for humans and livestock, and can be an indicator of *T. gondii* oocysts in the environment.

Wildlife disease biologist David Sinnett collecting blood samples from a black bear (*Photo: David Sinnett*)

The NWDP is collaborating with a variety of state and federal parners to learn more about the distribution, transmission and prevalence of *T. gondii* in wildlife. Researchers at the Animal Parasitic Diseases Laboratory of the Agricultural Research Service in Beltsville, Maryland, are experts in toxoplasmosis diagnostics and epidemiology. This laboratory is our key cooperator in toxoplasmosis surveillance in wildlife, which supports the broader goal of improving food safety in the U.S.

At the national level, serology for *T. gondii* antibodies is performed with sera from all feral swine sampled in 36 states. This year our goal is to collect over 3,000 samples for toxoplasmosis testing. The collaboration has enabled spatial analysis of the distribution of *T. gondii* in feral swine, which has focused sampling by wildlife disease biologists in four states. These biologists are collecting selected tissues and serum samples from feral swine in focal counties. The tissue collections will allow the Agricultural Research Service scientists to isolate and identify different genotypes of *T. gondii.* This information will increase our understanding of the strains of *T. gondii* circulating in feral swine, and potential spillover between feral swine and pasture-raised, domestic swine. A second goal is to find biomarkers in serum that correlate with genotypes of *T. gondii*, which would increase the value of sero-surveillance in the future.

At the state level, wildlife disease biologists are collaborating with state and local agencies as well as the Agricultural Research Service on other *T. gondii* surveillance projects. In 2009, the Alaska Department of Fish and Game initiated predator control work in some areas to relieve predation pressure on moose calves. Wildlife Services worked with the Department and private trappers to collect samples from carnivores, and the Agricultural Research Service was successful in identifying *T. gondii* genotypes and isolated a new atypical, mouse-virulent genotype from black bear (*Ursus americanus)* samples. Such atypical genotypes are thought to be associated with cases of active toxoplasmosis in immunocompetent persons who are resistant to typical genotypes. These results can be found in the paper by Dubey *et al*. entitled, "A New Atypical Highly Mouse Virulent *Toxoplasma gondii* Genotype Isolated from a Wild Black Bear in Alaska" [J Parasitol 96(4), 2010 pp.713-716].

Our wildlife disease biologist in Colorado also has been collaborating with the Agricultural Research Service on *T. gondii* prevalence and genotyping projects. Initial efforts focused on *T. gondii* prevalence in Colorado raptors and ground-feeding birds, which included the isolation of *T. gondii* from four new bird species: barn owl (*Tyto alba*), ferruginous hawk (*Buteo regalis*), rough-legged hawk (*Buteo lagopus*), and Swainson's hawk (*Buteo swainsoni)* [Serological and Parasitological Prevalence of *Toxoplasma gondii* in Wild Birds from Colorado, J Parasitol 96(5), 2010 pp.937-939]. Continued work includes the genotyping of *T. gondii* isolates from a variety of wildlife species across the United States, which has led to the recent submission of a manuscript currently in review at the International Journal for Parasitology. This paper, which includes Wildlife Services collaborations from Alaska, Colorado, Minnesota and Wisconsin, demonstrates four dominant genotypes of *T. gondii* in wildlife. Collaborative work on *T. gondii* continues in many other states.

Wildlife Services biologist Levi Hodson banding a red-tailed hawk

(*Photo: Todd Felix*)

US-China Collaborations on Wildife Diseases in Asia

By Dale Nolte and Hongxuan He

The Chinese Academy of Sciences (CAS) has become a primary partner for developing wildlife disease activities in Asia. The NWDP has collaborated with CAS to assess disease risk posed by wild birds since 2006. Initially, surveillance efforts focused on Qinghai Lake, where numerous wild birds died during 2005. Surveillance was subsequently expanded to Ponyong Lake, Hebei, Yellow River, and Inner Mongolia. The NWDP also has hosted CAS and Chinese State Forestry Administration (SFA) officials for scientific exchanges and training in the United States.

The NWDP and CAS have worked together to increase capacity and enhance communication among Asian countries through workshops and conferences. CAS provided regional expertise to support NWDP workshops conducted in Cambodia, Lao PDR and Thailand. Our first jointly sponsored workshop was held during 2008, with a focus of bringing countries together to discuss potential movement of wildlife diseases between the Asian and North American continents. The following year NWDP participated in a special session on Infectious Diseases sponsored by CAS in Beijing. In 2010, the NWDP, CAS, and SFA worked together to conduct the Asia-Pacific Conference on Wildlife Borne Diseases; 13 countries sent representatives to share scientific expertise on wildlife-borne diseases. A concept for a wildlife disease communication network was developed at the conference as well. The goal of the network is to provide the opportunity for members to communicate and share experiences on diseases of mutual interest or concern. The network also can serve to identify training needs for countries and potential workshops to address those needs.

Wildlife Services, Chinese State Forestry Administration, and Chinese Academy of Science officials after a recent meeting near Shenyang (*Photo: Dale Nolte)*

The NWDP also is working with CAS and SFA to enhance China's capacity to conduct wildlife disease surveillance. The SFA is developing an extensive wildlife disease surveillance system across China and recognizes the need for a One Health approach to addressing disease risk. Their objective is to ensure that China is equipped and prepared to address any emerging disease concern in wildlife. Last November a SFA contingent visited Fort Collins, CO and Washington DC to learn about the programmatic approach used to conduct surveillance in the United States. They have requested that the NWDP provide technical training to increase their field staff's skills in sampling for diseases in wildlife.

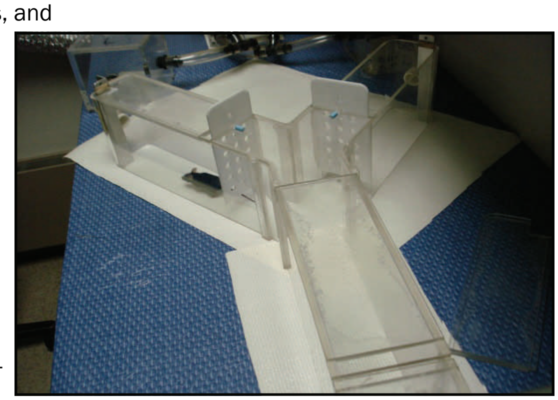
Finally, the NWDP is working with CAS to develop a workshop to share recent surveillance information on highly pathogenic avian influenza and other wildlife diseases that impact agriculture or human health. The hope is that the 2008 participating countries (Canada, China, Mongolia, Russia, United States) will return and be joined by representatives from other countries such as Cambodia, Japan, South Korea, Thailand, and Vietnam.

*(**Biosensor Development,** Continued from page 4)*

their body odor. During exposure tests, female mice avoided locations containing soiled bedding from parasitized males. Female mice also avoided nest boxes contaminated with the urine of males infected with influenza. Studies with marine animals have shown an avoidance of healthy animals from fungal infected animals.

There also have been studies that demonstrated attraction of insect vectors to humans infected with a pathogen. For example, children harboring the parasite *Plasmodium falciparum* attracted twice as many mosquitoes as children uninfected with the malarial parasites.

The development of a real-time detection system that can identify and locate an animal infected by a specific pathogen, or a tissue or secretion from such an individual, would be a valuable tool for managing diseases in humans, domestic animals, and wildlife. The NWDP is collaborating with Wildlife Services' National Wildlife Research Center, the Monell Chemical Senses Center, and Colorado State University to develop "biosensor" and instrumental techniques to detect odor changes of mallard (*Anas platyrhynchos*) feces resulting from infection with low pathogenic avian influenza virus. Live mouse biosensors have been trained to discriminate between feces from infected and uninfected ducks on the basis of odor. These results indicate that a canine model can similarly be developed for field deployment. Currently, instrumental techniques are being evaluated to quantify odor changes and potentially lead to development of mechanical sensors for disease surveillance.



A mouse biosensor that has been trained to discriminate between feces of infected ducks vs. healthy ducks (*Photo: Bruce Kimball)*

Foot-and-Mouth Disease Pocket Guide for Feral Swine

By Brandon Schmit

Foot-and-mouth disease (FMD), a highly contagious acute vesicular disease of cloven-hoofed animals, represents a significant threat to American agriculture. The FMD virus may be transmitted by: 1) direct contact with infected animals, their secretions or products, 2) aerosolization of the virus, and 3) mechanical vectors such as humans, trucks, and potentially vertebrate and invertebrate wildlife. Although FMD is not currently found within the United States, feral swine have been identified as a high risk pathway for the transmission of vesicular foreign animal diseases like FMD. In both feral and domestic swine, FMD virus amplifies rapidly and infected animals release large quantities of virus into their environment. An introduction of FMD into feral swine populations would put local susceptible wildlife at risk as well as jeopardize any commercial swine or cattle operations that may exist in the vicinity. Disease surveillance in commercial livestock is often passive because many people are observing the animals on a daily basis and individuals showing clinical signs are often easy to identify. Surveillance for foreign animal diseases in wildlife requires increased vigilance and an active approach, as the majority of the individuals within a population of interest go completely unobserved and untested.

As part of a comprehensive plan to implement FMD surveillance in feral swine, individuals will be actively screened for signs of vesicular disease consistent with FMD whenever the opportunity arises. To facilitate this screening process in the field, a pocket guide was created to serve as a reference for identifying lesions consistent with FMD infection in feral swine. This pocket guide was a cooperative effort that included contributions from several USDA Animal and Plant Health Inspection Service programs, the American Association of Swine Veterinarians, National Pork Board, and the Center for Food Security & Public Health at Iowa State University. The guide uses close-up photographs of the feet, mouth, and snout to clearly document the progression of the disease from the first day of infection through day 26, when most lesions are in the latter stages of healing. The last two pages outline procedures to follow if a foreign animal disease consistent with FMD is suspected and include a case definition, national contact information for State Animal Health Officials, Area Veterinarians in Charge, as well as the Wildlife Services Hotline.

The NWDP will receive 600 of the 3600 copies to be printed (available early summer). Copies will be distributed to all state Wildlife Services programs that will be involved with FMD surveillance in feral swine. Please contact Brandon Schmit (Brandon.S.Schmit@aphis.usda.gov) to request additional copies.

RECENT NWDP PUBLICATIONS

Blizzard, EL, MJ Yabsley, TN Nims, and LGarrison. 2010. Intestinal roundworm (*Baylisascaris procyonis*) of raccoons (*Procyon lotor*): Information for public health and wildlife professionals. Wildlife Management Publication Series 10-22. Warnell School of Forestry and Natural Resources, University of Georgia. 7pp.

Carlson, JC, RM Engeman, DR Hyatt, RL Gilliland, **TJ DeLiberto**, L Clark, MJ Bodenchuk, and GM Linz. 2011. Efficacy of European starling control to reduce Salmonella enterica contamination in a concentrated animal feeding operation in the Texas panhandle. BMC Veterianry Research 7:9.

Dong G, J Luo, H Zhang, C Wang, M Duan, **TJ Deliberto, DL Nolte**, G Ji, and H He. 2011. Phylogenetic Diversity and Genotypical Complexity of H9N2 Influenza A Viruses Revealed by Genomic Sequence Analysis. PLoS ONE 6(2): e17212. doi:10.1371/journal.pone.0017212.

Mohamed F, S Swafford, H Petrowski, A Bracht, **B Schmit**, A Fabian, JM Pacheo, E Hartwig, M Berninger, C Carrillo, G Mayr, K Moran, D Kavanaugh, H Leibrecht, W White, S Metwally. 2011. Foot-and-Mouth Disease in Feral Swine: Susceptibility and Transmission. Transboundary and Emerging Diseases. doi:10.1111/j.1865-1682

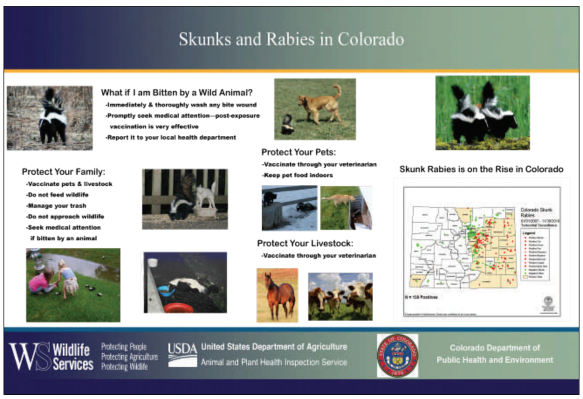
Shock, BC, SM Murphy, LL Patton, PM Shock, C Olfenbuttel, J Beringer, S Prange, DM Grove, M Peek, JW Butfiloski, DW Hughes, JM Lockhart, **SN Bevins**, S VandeWoude, KR Crooks, VF Nettles, HM Brown, DS Peterson and MJ Yabsley. 2010. Distribution and prevalence of *Cytauxzoon felis* in bobcats (*Lynx rufus*),the natural reservoir, and other wild felids in thirteen states. Veterinary Parasitology 175: 325-330.

State Highlights

Western Region

Colorado

In cooperation with the Colorado Department of Public Health and Environment , wildlife disease biologist Todd Felix produced a poster on “Skunks and Rabies in Colorado.” Skunk rabies has been on the rise in Colorado for the past few years. Increases in the number cases and the geographic distribution of these cases have increased the potential for exposure to humans, pets,



and livestock. The poster, which was displayed at Wildlife Services' educational booth at the National Western Stock Show, was designed to increase awareness and provide information on protecting humans, pets, and livestock from skunk rabies. Todd also worked with the Colorado Department of Public Health and Environment to provide informational pamphlets on skunk rabies to interested parties at the Stock Show.

Nevada

District Supervisor Jack Spencer Jr. and wildlife disease biologist Zach Bowers traveled to Paradise Valley, NV to conduct a feral swine project. It’s uncertain how long feral swine have been in the area, but Wildlife Services started receiving damage reports from ranchers about 15 years ago. The feral swine cause considerable damage to riparian areas and also to the surrounding rangeland. It is not uncommon for ranchers to incur significant losses in winter when the feral swine start targeting their hay stacks. Jack and Zach coordinated crews of Wildlife Services employees and dogs, who pushed the thick brush in an attempt to force the feral swine out into the open where an aerial crew could safely engage them. After several hours, 10 feral swine were chased out into the open and shot by the air crew. Zach was able to sample nine of the feral swine for classical swine fever, swine brucellosis, pseudorabies, plague, and tularemia.

Eastern Region

Alabama

On January 12, 2011, a mortality event of hundreds of blackbirds took place adjacent to I-65 in Limestone County. Wildlife disease biologist Wes Gaston worked with the Alabama Department of Conservation and Natural Resources, US Fish and Wildlife Service, the Alabama State Veterinarian, and the Alabama State Public Health Veterinarian to ensure that a subsample of birds were collected for avian influenza testing at the state diagnostic laboratory. The lab results indicated that the birds died from blunt trauma and tested negative for avian influenza and other diseases. During the time of the event, the ground was covered in 6 inches of snow for 6 days, and the only exposed ground for the birds to feed on was associated with road systems. It is likely that the birds were feeding near and/or on the interstate, and were hit by one or more vehicles as they attempted to fly; many of the carcasses were found on the interstate and along the shoulder. The birds were found within a mile of a known roost where approximately 1 million blackbirds congregate.

Michigan

Wildlife disease biologist Dave Marks has been collaborating with the NWDP office in Fort Collins, CO, wildlife disease biologists Barbara Bodenstein (WI) and Justin Gansowski (NY), and Michigan State University diagnostic laboratory to develop a health surveillance program for mute swans (*Cygnus olor*) in the Great Lakes region. Current plans are to test swans for Newcastle disease virus, salmonella, avian influenza, and internal parasites. The project is in association with a mute swan management program developed as part of the Great Lakes Restoration Initiative. The mute swan management program is a collaboration with the Michigan Department of Natural Resources, the US Fish and Wildlife Services, and the USDA Forest Service to develop a strategy for managing this invasive species.

National Wildlife Disease Program

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Photos of the Quarter

Wildlife disease biologist Marcus Gray anesthetizing a raccoon for rabies surveillance in Virginia.

Wood duck drakes captured by wildlife disease biologist Marcus Gray and the Virginia Department of Game and Inland Fisheries staff for highly pathogenic avian influenza surveillance.