National Wildlife Disease Program

The Carrier

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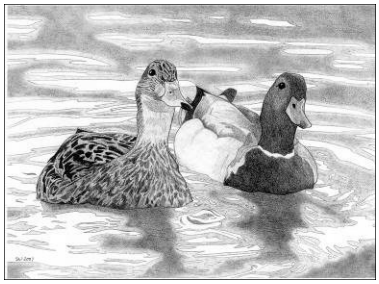

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Program Commentary

By Dr. Thomas DeLiberto

Understanding factors responsible for the emergence and re-emergence of diseases is one of the most difficult scientific problems facing society. Significant knowledge gaps exist for even the most studied infectious diseases. Coupled with failures in the response to resurgence of infectious diseases, this lack of information is embedded in a simplistic view of pathogens, and disconnected from a social and ecological context. A more realistic view of emerging infectious diseases requires a holistic perspective that incorporates social as well as physical, chemical, and biological dimensions of our ecosystems.

The resurgence of infectious diseases is clearly associated with the social and demographic changes of the past 50 years, particularly urbanization and globalization, with the attendant spread of pathogens via infected humans, hosts, vectors, and commodities. Change in the environment caused by human activities is also apparent in the transformation of much of our landscape once dominated by natural ecosystems. Likewise, the inadequate storm drainage and sewage systems often associated with rapid urbanization in developing regions, not only increase the breeding habitat for disease vectors, but also facilitate the spread of water-borne pathogens.

However, resurgence of infectious disease is not the inevitable result of development, environmental change, or even incremental human population growth. On the contrary, much can be done to reverse the current trend. There is substantial evidence and a growing number of examples of how regional planning and development, including urbanization, agricultural expansion, and the management and conservation of forests and other ecosystems, can minimize and even reduce outbreaks of infectious disease, as well as environmental damage.

Basically we need an integrated, One Health approach to pathogen control. This approach should involve meshing social and economic development programs, and environmental and natural resource management, with intervention based on the reinvigorated field of disease ecology and methods that involve community participation. To do this, we have to take an ecological approach to medicine. While many factors may affect each of the wildlife, domestic animal, and human fields of medicine, ultimately, it is the interaction of these fields with our ecosystems that will allow us to more fully understand disease emergence and develop comprehensive solutions to battling such diseases.

No issue could be a more fundamental measure of sustainability than public health, and the increasing emergence and re-emergence of infectious diseases globally is possibly the world's most challenging public health problem today. Yet solutions will continue to elude us without a vastly broadened perspective, if not an entirely new paradigm, that integrates ecosystem and domestic animal health with public health. This new paradigm will not be reached easily and will require science and education initiatives that cross disciplinary as well as institutional, societal, and cultural boundaries. Without appreciating the complex dynamic between social and ecological processes, and employing the related frameworks and perspective, we will forgo the ability to gain insights into the underlying causes of the recent increase in emerging infectious diseases.

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)

Controlling Feral Swine During Emergency Disease Outbreaks

By Dr. Tyler Campbell

Feral swine (*Sus scrofa*) are susceptible to a wide range of pathogens, including many that are not currently known to occur in the United States, yet would cause tremendous agricultural losses should they become established. In the event that a feral swine emergency disease outreak should occur, cost-effective means of controlling disease exposure and transmission are needed. The NWRC Feral Swine Project and its collaborators, including the NWDP, have embarked on a series of experiments aimed at determining the best management practices for controlling feral swine emergency disease epidemics in the high risk southern Texas border region.

GPS collared feral pig

First, aerial gunning on feral swine was studied to determine if it altered home range and core area sizes, distances between home range centroids, and distances moved by surviving individuals. Data were collected pre-, during-, and post-aerial gunning in southern Texas. Using Global Positioning System collars deployed on 25 adult feral swine at 2 study sites, we found home range and core area sizes did not differ between pre and post aerial gunning.; however, feral swine moved at a greater rate during the aerial gunning phase than during the pre and post periods. Thus, aerial gunning had only minor effects on the behavior of surviving swine and that this removal

(Continued on page 4)

The History of Foot and Mouth Disease in North American Cervids

By Dr. Tom Gidlewski

At December's Foreign Animal Disease Diagnostician's course at Plum Island, NY, the subject of Foot and Mouth (FMD) disease in cervids was discussed, bringing up once again the outbreak of FMD among deer in the Stanislaus National Forest in the early 2oth century.

The first reported outbreak of Foot and Mouth Disease in the United States was in 1870. Subsequent outbreaks occurred in 1880, 1884, 1902, 1908, 1914, 1924 and 1929. There were actually two unrelated outbreaks in 1924, in Texas and California. These early cases were believed to be associated with contaminated biologics and garbage of foreign origin. The "Tariff Act of 1930" is believed to have curtailed these outbreaks by the imposition of an embargo against the importation of domestic ruminants and swine, as well as parts thereof, from countries known to have rinderpest or FMD.

Foot and mouth disease lesions on hoofs of mule deer

The 1924 California outbreak was first discovered in West Berkeley, Alameda County, during February. This is the only FMD outbreak in the United States believed to have significantly involved wildlife.

The origin of the outbreak appeared to be the feeding of contaminated navy garbage in December of 1923. The eradication appears to have been a true state-federal cooperative effort. State quarantines were issued, guards were posted, livestock were appraised by a state and a federal appraiser and indemnity payments were shared equally by the state and federal governments. Trenches were dug, animals were driven into the trenches and shot, carcasses were eviscerated and limed, and then the trenches were covered. The outbreak spread from north central (Bay area) to southern California (Los Angeles area). The final livestock cases

(Continued on page 6)

Epizootic Hemorhaggic Disease and Bluetongue Virus Surveillance

By Mark Lutman

Bluetongue virus (BTV) and Epizootic hemorrhagic disease virus(EHDV) can cause devastating disease in ruminants, including deer, sheep, and other livestock. It is estimated that BT costs the United States' cattle and sheep industry $125 million annually and $3 billion world-wide. EHDV can have high mortality rates which can significantly reduce local deer populations. These viruses are transmitted by several species of *Culicoides*, also known as biting midges or no-see-ums. Both viruses are found in the genus *Orbivirus* with numerous subtypes found throughout the world. In the U.S., there are 6 serotypes of BTV (1, 2, 10, 11, 13, and 17) and 3 serotypes of EHD (1, 2, and 6). Recent outbreaks of BTV-8 in Europe have prompted concerns that these foreign strains could enter the U.S. and have devastating impacts on livestock and wildlife.

State	Number of trap nights
Maine	30
Maryland	28
Montana	24
New Jersey	33
New York	10
North Dakota	7
Total	**132**

The NWDP is collaborating with USDA Agricultural Research Service to identify hot spots where EHDV/BTV outbreaks are occurring and set up surveillance around these locations. One objective is to identify the distribution/diversity of *Culicoides*

(Continued on page 4)

Surveillance for Canine Parvovirus in Wildlife

By Dennis Kohler

Canine parvovirus is a pathogen that can infect most canids. The disease likely emerged in domestic dogs in Europe during the 1970s and rapidly spread throughout the world in domestic and wild species. Scientists at the NWRC revealed that canine parvovirus entered western United States coyote populations during 1978 and serological data suggested it was enzootic in coyotes by 1980.

Canine parvovirus typically causes disease by infecting bone marrow, lymph nodes, spleen, and intestines in young animals that no longer have protection from maternal antibodies. The most common clinical sign is pronounced hemorrhagic enteritis (bloody diarrhea). Canids that become infected as adults often have no symptoms, but can remain infectious for up to 6 weeks. Although transmission through direct contact with infected animals is important, indirect contact with infected environments likely plays a more important role in the transmission and maintenance in a population. Canine parvovirus is extremely stable in the environment and transmission can occur when a susceptible animal has contact with feces, infected soil, or fomites.

Coyote

While canine parvovirus can be controlled through environmental decontamination and vaccination of domestic animals and wild canids in captivity, implementation of such protocols in wild populations is not currently practical.

Although viral shedding has been documented in wild canids, most studies to date have focused on serological surveillance. To gain a better understanding of canine parvovirus in wild coyotes, the NWDP initiated a collaborative effort with Cornell University to determine the distribution of canine parvovirus by identifying viral particles in tissues and feces.

To date, the NWDP has collected 799 individual animals from 18 different carnivore species from 32 states and the territory of Puerto Rico for canine parvovirus testing . Diagnostic analysis has been completed on 355 animals with the results indicating that 13 states have parvovirus positive wild carnivores.

(Epizootic Hemorhaggic Disease and Bluetongue Virus Surveillance — Continued from page 3)

species in these areas. A second objective is to test for EHDV/BTV virus in the *Culicoides* and ultimately identify which species are vectors for the viruses in the region.

Wildlife disease biologists identified trapping locations and set out CDC Light Traps in the evening and left them overnight to capture insects. The CDC Light Trap has an ultraviolet black-light as the light source as well as a canister of dry ice to emit CO_2 throughout the night. Insects were removed from the traps in the morning and immediately placed on dry ice. All insects were shipped to the NWDP weekly during the collection period to be sorted and identified. After identification, insects were tested by the Agricultural Research Service laboratory in Manhattan, KS using a multiplex real-time reverse transcription polymerase chain reaction (RT-PCR) that can simultaneously screen for multiple serotypes of both BTV and EHDV.

Insects collected in a CDC Light Trap

In FY2012, EHDV/BTV surveillance was conducted in 6 states that had reported deer die-offs due to EHDV. CDC Light Traps were set up near these locations to trap Culicoides that will be identified and tested later this year. A total of 132 trap nights were conducted during Fiscal Year 2012.

Surveillance this year is being expanded to approximately 10 states due to more states reporting deer die-offs from EHDV.

(Controlling Feral Swine During Emergency Disease Outbreaks — Continued from page 2)

method should be considered a viable tool in contingency planning for a feral swine emergency disease outbreak.

Second, fenced enclosures built of 0.86-m-tall traditional hog panels were evaluated for containing feral swine during 35 trials, each involving 6 recently caught animals exposed to increasing levels of motivation. During trials, fences were 97% successful when enclosures were entered by humans for maintenance purposes; 83% effective when pursued by walking humans discharging paintball projectors; and in limited testing, 100% successful when pursued and removed by gunners in a helicopter. In addition to being effective in containing feral swine, enclosures constructed of hog panels required simple hand tools, took <5 min/m to erect, and were inexpensive ($5.73/m excluding labor) relative to other fencing options. As such, hog-panel fences are suitable for use by state and federal agencies for rapid deployment in emergency disease outbreaks.

Lastly, the effects of baiting on feral swine movements and corresponding likelihood of disease spread under real and simulated culling pressure were studied. Feral swine were trapped (n=83) and GPS collars were placed on 21 animals. A centralized bait station was established and maintained on one side of the study site. Population-wide culling activities, including trapping, controlled shooting, drive shooting, and aerial gunning were conducted. One hundred and forty-three feral swine (4.6 feral swine/km2) were removed. Areas of utilization did not differ between treatments (control or bait station); however, location centroids of feral swine at bait station sites were closer to the treatment location than those of control site animals. Daily movement rates of feral swine at bait station sites were also 39% greater than movement rates of control site animals. This study suggested that there is value in using bait stations to describe patterns of feral swine movements, facilitate observation, and improve efficacy when conducting removals associated with disease outbreaks.

Suggested Readings:

Campbell, T.A., D.B. Long, M.J. Lavelle, B.R. Leland, T.L. Blankenship, and K.C. VerCauteren. 2012. Impact of baiting on feral swine behavior in the presence of culling activities. Preventive Veterinary Medicine 104:249–257.

Campbell, T.A., D.B. Long, and B.R. Leland. 2010. Feral swine behavior relative to aerial gunning in southern Texas. Journal of Wildlife Management 74:337–341.

Lavelle, M.J., K.C. VerCauteren, J.W. Fischer, G.E. Phillips, T. Hefley, S.E. Hygnstrom, S.R. Swafford, D.B. Long, and T.A. Campbell. 2011. Evaluation of fences for containing feral swine under simulated depopulation conditions. Journal of Wildlife Management 75:1200–1208.

Search for Wildlife Reservoirs of Zoontic Disease

By Dr. Sarah Bevins

Collaborators from Colorado State University recently traveled to Cambodia as part of a joint project with NWDP that is attempting to identify wildlife reservoirs of zoonotic infectious diseases. Much of this research was initially motivated by an interest in Chikungunya virus, a mosquito transmitted disease that can cause serious illness in people and is present in large portions of Southeast Asia. The name means, "that which bends up," and was given by an ethnic group in Africa to describe the severe joint pain that accompanies infection. There is concern that it could become established in the United States if unintentionally introduced, similar to what was seen with West Nile virus in the late 1990's. A wildlife reservoir has yet to be conclusively identified for Chikungunya virus, limiting our ability to understand transmission and to develop a response protocol in the event of an outbreak. There is some recent experimental laboratory infection data that suggests reptiles are a competent reservoir for the virus, but this has yet to be explored in the field.

Flower's long-headed lizard sampled as part of zoonotic disease surveillance in Cambodia

Sarah Bevins restraining a rainbow water snake in Cambodia

Processing samples at the NAMRU-2 laboratory in Phnom Penh

Scientists traveled to Cambodia to collect blood samples from a wide-range of wildlife species found throughout the country. Cambodia recently suffered the highest number of documented human Chikungunya cases seen within the last 30 years and wildlife collection sites for this surveillance project were centered on regions that had reported substantial numbers of human infections.

Sampling focused on reptiles and amphibians, including snakes, lizards, skinks, geckos, frogs, and toads. Additional sampling also incorporated multiple bat species, as well as rice rats, all of which could potentially play a role in the transmission cycles of multiple infectious diseases in the region, including Chikungunya virus, Nipah virus, and lyssaviruses. Samples will all be run through pathogen discovery assays which will allow collaborators to screen for a variety of pathogens, both known and unknown.

In total, samples were taken from nearly 1,000 animals which should provide unprecedented insight into the zoonotic pathogens these wildlife species are exposed to and should also pinpoint active infections. Better understanding of which species play a role in disease transmission will help determine if these pathogens could in fact become established in the United States, while also shedding light on how outbreaks occur in Cambodia and nearby regions.

This collaboration between Colorado State University and NWDP also involved the Cambodian Forestry Administration. Help was also provided by the Navy Army Medical Research Unit 2 and the Centers for Disease Control and Prevention office, both located in Phnom Penh, Cambodia.

(The History of Foot and Mouth Disease in North American Cervids — Continued from page 2)

were discovered in October of 1924. What might be considered the second wave of this FMD battle began in July, 1924 when the first cases of FMD were discovered in the Stanislaus National Forest mule deer. The Forest is located in the Sierra Nevada Mountains about 25 miles east of Sonora, California or 150 miles east of the index case in Berkeley, California. Infected cattle had previously been discovered in this forest and destroyed. Very sick deer that were reluctant to move demonstrated classic lesions. Similar lesions were noted in deer found dead. The state and federal authorities "where somewhat at sea" as how to proceed. The disease had not been described in free ranging animals and the only known remedy for this disease in domestic animals was eradication.

The U.S. Biological Survey, which was the agency in the Department of Agriculture responsible for predator control, was tasked with determining the extent of the FMD infection in the Stanislaus Forest deer. It was July and the deer were on the high summer range. Deer had to be collected and examined, yet dispersal had to be kept to a minimum. Strychnine was chosen because of historical performance in other species. It was mixed with salt and placed in salt logs that the deer had traditionally shared with livestock. Forty-three deer were killed and examined and 30% had lesions consistent with FMD. Some of the lesions were chronic, suggesting that the agent had been circulating for some time which was consistent with the history of disease in the commingled cattle. It was the end of August, they knew they had a problem and it would not be long before breeding season and migration to winter ranges would compound the issue. A large scale campaign of poisoning the deer was begun. Coincident with this, protests to the killing began and remained throughout the deer removal activities.

With the approach of winter, the deer began to migrate to the lower winter feeding grounds and also began to refuse the poisoned salt. Throughout the winter, shooting was the primary means of removal and utilized about 250 hunters distributed over 40 camps.

Yosemite Park was threatened during this event, but luckily escaped widespread infection. The eradication activities were continued in the Stanislaus National Forest into the winter of 1926 finally ceasing in March. The last positive deer was removed in June, 1925. As many as 30,000 deer were destroyed over about 1,000 square miles during 22 months. It is one thing to battle a pathogen armed with molecular diagnostics and volumes of research, but it is quite another to battle a filterable agent diagnosed by animal inoculation encountered in a novel species.

The vast majority of information on this topic was taken from the California Department of Agriculture Bulletins.

Suggested Reading:

Keane, C. 1927. The outbreak of foot and mouth disease among deer in the Stanislaus National Forest. California State Dep. Agric. Mon. Bull. 16: 213–

Recent NWDP Publications

Allison, A. B., **D. J. Kohler,** K. A. Fox, J. D. Brown, R. W. Gerhold, V. I. Shearn-Bochsler, E. J. Dubovi, C. R. Parrish, and E. C. Holmes. 2013. Frequent cross-species transmission of parvoviruses among diverse carnivore hosts. Journal of Virology 87:2342-2347.

Brown V.L., Drake J.M., Stallknecht D.E., Brown J.D., **Pedersen K.,** Rohani P. 2013. Dissecting a wildlife disease hotspot: the impact of multiple host species, environmental transmission and seasonality in migration, breeding and mortality. J R Soc Interface 10:20120804. DOI: 10.1098/rsif.2012.0804.

Clavijo, A., Nikooienejad, A., Esfahani, M. S., Metz, R. P., Schwartz, S., Atashpaz-Gargari, T.**J. Deliberto, M.W. Lutman, K. Pedersen** et al. (2012). Identification and Analysis of the First 2009 Pandemic H1N1 Influenza Virus from US Feral Swine. *Zoonoses and Public Health*.

Hjulsager C.K., Breum S.Ø., Trebbien R., Handberg K.J., Therkildsen, Ole Roland , Madsen J.J., Thorup K., **Baroch J.A., DeLiberto T.J.**, Larsen L.E., Jorgensen P.H. 2012. Surveillance for Avian Influenza Viruses in Wild Birds in Denmark and Greenland, 2007–10. Avian Diseases 56 (4): 992–998.

Nemeth, N., A. Bosco-Lauth, P. Oesterle, **D. Kohler**, and R. Bowen. 2012. North American birds as potential amplifying hosts of Japanese encephalitis virus. American Journal of Tropical and Medical Hygiene 87:760-767.

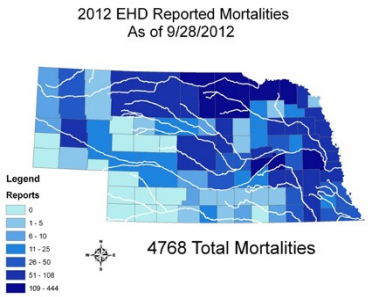
Wang C, Zhang Y, Wu B, Liu S, Xu P, Liu S, Xu P, **Nolte DL, Deliberto TJ,** Duan M, Zhang H, and He H 2013. Evolutionary Characterization of the Pandemic H1N1/2009 Influenza Virus in Humans Based on Non-Structural Genes. PLoS ONE 8(2): e56201. doi:10.1371/journal.pone.0056201

STATE HIGHLIGHTS

Western Region

Nebraska

Wildlife Disease Biologist Dallas Virchow coordinated with local government agencies to maintain situational awareness of the epizootic hemorrhagic disease outbreak occurring in Nebraska white-tailed (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) populations. Evidence of the epizootic became known in mid-August 2012 and by September 28th, almost 5,000 deer mortalities had been reported and attributed to this disease. During 2012, there were an unusually high number of deer mortalities relative to previous years.



Montana

Wildlife Disease Biologist Gerry Wiscomb coordinated the collection of biological samples for a diverse number of wildlife disease surveillance projects. He collaborated with Wildlife Services' biologists and specialists to collect over 1,000 surveillance samples from eight species, including 821 samples for tularemia, 818 sample for plague, 19 for leptospirosis, and 60 for canine parvovirus. Specifically, Gerry is submitting blood/serum samples collected from coyotes removed during wildlife management activities, contributing to the leptospirosis surveillance project initiated by the NWDP.

Oklahoma

During the summer, Wildlife Disease Biologist Pat Whitley collected insects for bluetongue virus and epizootic hemorrhagic disease virus in a CDC Light Trap placed near a pond with a muddy substrate, which is heavily used by domestic cattle and white-tailed deer (*Odocoileus. virginianus*). The collected insects were placed on dry ice early the next morning and shipped to the NWDP in Fort Collins, CO. Once the insects arrived, they were sorted by species to determine if *Culicoides* species were present; if they were found, they were tested for the viruses. The goals of this project are to identify the distribution and diversity of *Culicoides* species in outbreak areas, and to test *Culicoides* for the viruses to identify which species are vectors.

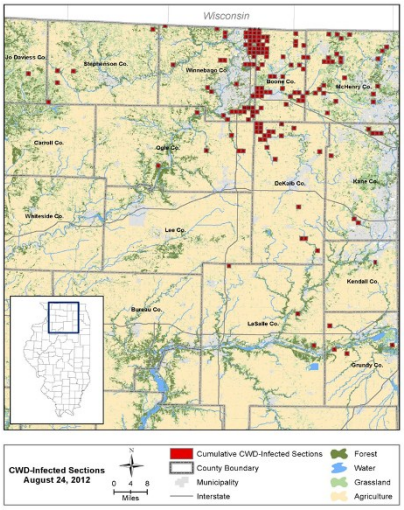
Eastern Region

Florida

In Florida, Wildlife Disease Biologist Mike Milleson, along with other biologists, assisted the Florida Fish and Wildlife Conservation Commission in collecting surveillance samples from cormorants for a Newcastle disease virus survey. Additionally, assistance was provided on a feral swine project at Buck Island Ranch; 15 feral swine were trapped to collect samples for two projects. The first will utilize the Lawrence Livermore Pathogen Detection Array to analyze feral swine fecal and blood samples for over 2,000 known pathogens. The second will investigate non-invasive methods of buccal cell collection for obtaining DNA. Lastly, Mike met with researchers from Archibold Biological Station, to examine the role of feral swine in the spread of red root (*Lachnanthes caroliana)*.

Illinois

Chronic wasting disease was first discovered in Illinois in 2002, and the Illinois Department of Natural Resources immediately allowed liberalized hunting and implemented a targeted sharpshooting program as a means to reduce deer numbers. By June 2012, more than 66,000 wild white-tailed deer had been tested and 372 positive animals were identified. Most positive animals were located within 3 miles of the initial core area, and over 90% of the cases were found within the original four positive counties. Wildlife Disease Biologist Tim White transported a NWDP emergency response trailer to Illinois at the request of cooperators to assist with CWD sample collection.



New Jersey

Wildlife Services was contacted by the U.S. Fish and Wildlife Service for information regarding the proper euthanasia of snapping turtles recovered from a Superfund clean-up at a remediated waste lagoon. Wildlife Disease Biologist Adam Randall assisted in developing sampling protocols, and with field collection and preparation of any turtles collected for sample extraction.

National Wildlife Disease Program

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PHOTOS OF THE QUARTER

Wildlife Disease Biologist Adam Randall assists the U.S. Fish and Wildlife Service with snapping turtles at a Superfund clean-up site

Wildlife Disease Biologist Mike Milleson works on a Newcastle disease virus survey in cormorants with the Florida Fish and Wildlife Conservation Commission