# One Health Newsletter

*Volume 7, Issue 2*

*This quarterly newsletter is dedicated to enhancing the integration of animal, human, and environmental health for the benefit of all by demonstrating One Health in practice.*


Feral swine, p.4


Food security & nutrition, p.7


Certificate in One Health, p.10

## *In this issue:*



***Proud Partner of:***

http://onehealthinitiative.com

*Please email our co-editors with questions, comments, or suggestions for articles, upcoming events, or publications to share relevant to One Health.*

*Please visit http://epi.ufl.edu/onehealth to learn more about the One Health Center of Excellence at the University of Florida.*

# The Natural History of Eastern Equine Encephalitis Virus in Florida

Jonathan F. Day, PhD

Eastern equine encephalitis virus (family *Togaviridae*, genus *Alphavirus*, EEEV) is a zoonotic arbovirus that is endemic throughout most of Florida. The EEEV is a complex of four lineages. One is highly pathogenic to humans and horses in North America and the Caribbean Basin. The remaining three lineages are pathogenic to equids, but only mildly pathogenic to humans in Central and South America (Arrigo, et al, 2010). In North America, the virus is reported in the eastern half of the USA from Texas east through the Gulf Coast states and from all of the Atlantic coast states as far north as New Hampshire. Sporadic EEEV outbreaks in humans and horses have been reported from central New York, Wisconsin, Michigan, and Indiana.

In all likelihood, EEEV has been present along the east coast of North America for centuries, and retrospective analyses suggest that the virus was the cause of equine epizootics in 1831, 1845, 1902, 1905, 1908, and 1912 (Hanson, 1957). Periodic equine epizootics have been reported in South America since 1908. The virus was first isolated in 1933 from horse brains associated with an epizootic along the Delaware, Maryland, New Jersey, and Virginia coasts. The first human epidemic caused by EEEV was reported in Massachusetts during the late summer of 1938. A total of 34 cases were reported with 24 from children less than 10 years of age. Twenty-five of the 34 reported cases died (74% case-fatality rate) (Scott and Weaver, 1989).

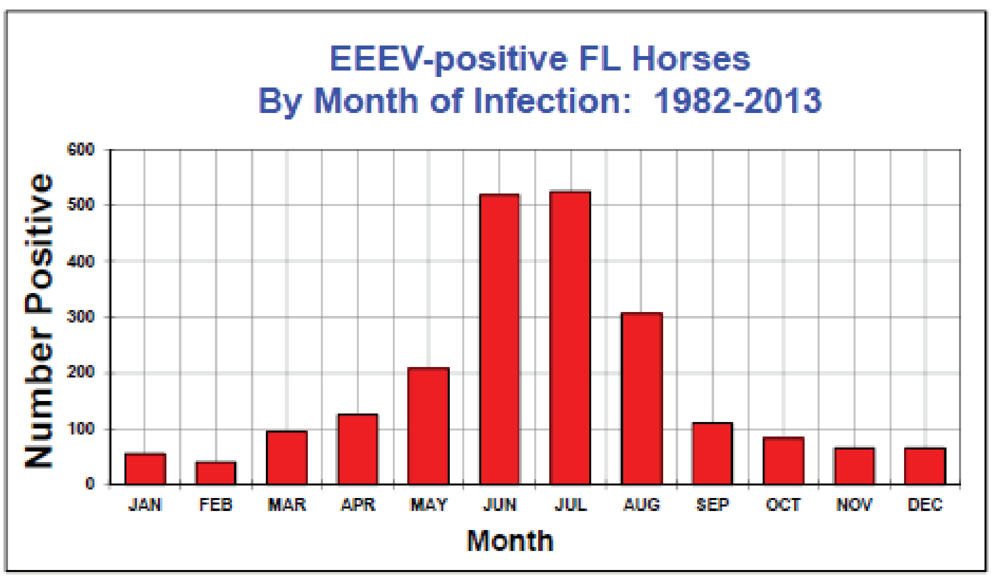



Figure 1. Total (by month) eastern equine encephalitis virus (EEEV)-positive horses reported in Florida, 1982-2013.

The EEEV can produce an acute central nervous system infection in susceptible humans, equines, other domestic animals, and some species of exotic birds (e.g. pheasants, parrots, and emus) (Day and Stark, 1996). Case fatality rates in equine epizootics are frequently greater than 80%. The case-fatality rate for humans with a symptomatic infection is greater than 75%, and there is currently no cure for human or animal infection, although an efficacious equine vaccine is currently available.

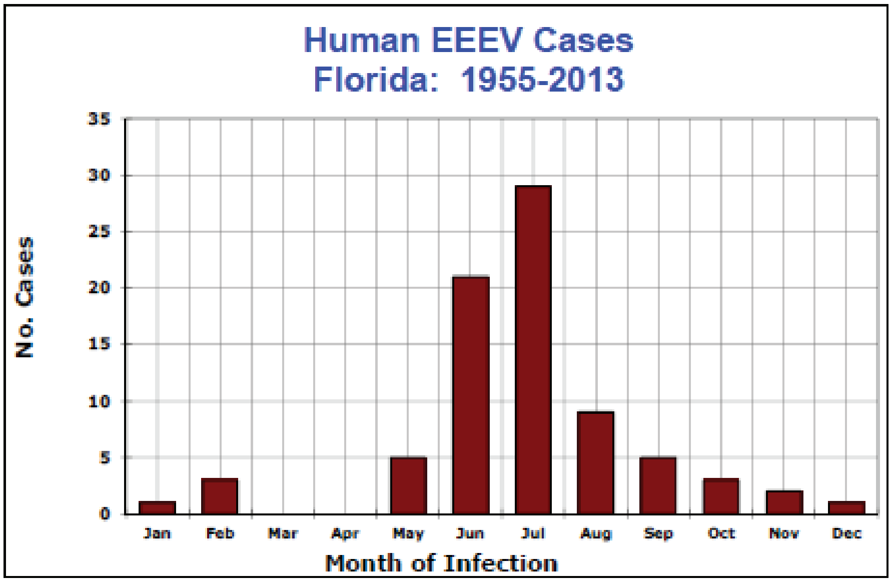



Figure 2. Total (by month) human eastern equine encephalitis virus (EEEV) cases reported in Florida, 1955-2013.

Epidemics and epizootics of EEEV occur cyclically. The total number of human cases reported nationally during a single transmission season has never exceeded 50, with an annual average of approximately six per year. However, 10 to 15 human cases have been reported during some transmission seasons. This is likely due to the importance of annual environmental cycles (especially rainfall and temperature) that drive the amplification and transmission of EEEV. Prior to the identification of EEEV as the etiological agent responsible for eastern equine encephalitis disease outbreaks, symptoms were collectively referred to as “summer fever.” Outbreaks caused by EEEV typically occur in August and September in the northern range of the virus and in June, July, and August in Florida (Figures 1 and 2). The earlier start to the transmission season in Florida is likely the result of hotter early summer conditions and the influence of the Florida wet season, which typically begins in May and runs through October, on vector mosquito population dynamics (Day and Curtis, 1994). Records of EEEV transmission to sentinel chickens, horses, and humans have been reported throughout Florida. However, an analysis of sentinel chicken seroconversion data (Day and Stark, 1996) suggests that the virus is most prevalent in north Florida and in the Florida Panhandle (Figure 3).

The EEEV transmission cycle is more complex than many other mosquito-borne arboviral transmission cycles (e.g., West Nile, St. Louis encephalitis, and dengue viruses). This is because the EEEV must complete two separate amplification cycles before the virus becomes a threat to dead-end hosts, including humans and horses (Figure 4). This is the primary reason that clusters of human and horse cases are uncommon. During the Florida dry season (November through April), the virus is maintained in freshwater swamps, where it cycles between *Culiseta melanura* (Coquillett) mosquitoes and avian amplification hosts. These endemic transmission cycles are extremely efficient and likely occur throughout the year as long as mosquito vectors and susceptible avian hosts are present in the swamp. However, *Cs. melanura* rarely feeds on mammals (Scott and Weaver, 1989), and a large portion of the endemic transmission cycle in freshwater swamps is limited to transmission between *Cs. melanura* and wild birds. Other mosquito species, some of which readily feed on mammals, are involved in the swamp transmission cycle and sometimes become important to EEEV transmission outside of the swamp. These endemic transmission cycles are extremely efficient and likely occur throughout the year as long as mosquito vectors and susceptible avian hosts are present in the swamp. However, *Cs. melanura* rarely feeds on mammals (Scott and Weaver, 1989), and a large portion of the endemic transmission cycle in freshwater swamps is limited to transmission between *Cs. melanura* and wild birds. Other mosquito species, some of which readily feed on mammals, are involved in the swamp transmission cycle and sometimes become important to EEEV transmission outside of the swamp.

The Florida wet season (May through October) produces environmental conditions that allow the dispersal of infected mosquitoes as well as infected avian amplification hosts out of the swamps. This movement of virus in infected vectors and avian hosts allows the establishment of secondary amplification foci in the drier habitats surrounding the swamps (Figure 4). Once EEEV is seeded into a secondary amplification focus, a variety of additional vector species become involved in the transmission cycle. These mosquitoes are often referred to as “bridge vectors” because they bridge the virus from infected birds to dead-end hosts. A variety of mosquito species can act as bridge vectors. In Florida, important bridge vectors include *Aedes vexans* (Meigen), *Coquillettidia perturbans* (Walker), *Culex nigripalpus* Theobald, and *Culex pipiens quinquefasciatus* Say. At the conclusion of the wet season or during extended periods of drought, mosquitoes withdraw into the wetter and more humid swamp habitats where endemic transmission is reestablished.

It is not surprising that the transmission of EEEV to dead-end hosts is closely linked to environmental conditions, especially rainfall that allows the dispersal of infected vectors out of the swamp habitats. During extensive periods of drought, it is unusual to record EEEV transmission outside of swamp habitats. When heavy rainfalls saturate the habitats surrounding the swamps, mosquitoes are likely to disperse across open habitats due to an increase in humidity associated with water-saturated soil and vegetation. Transmission of EEEV is most frequently reported in Florida in association with exceptionally wet spring conditions. Horses and humans living in close proximity to freshwater swamps are at the highest risk of infection, and it is generally in these habitats where virus transmission is first reported.

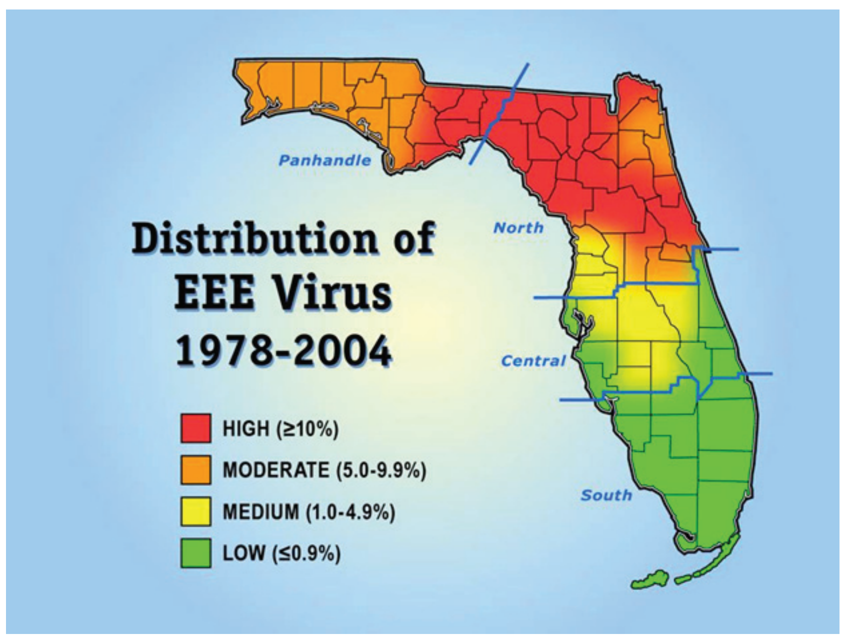



Figure 3. The spatial distribution of EEEV in Florida as measured by sentinel chicken seroconversion rates 1978-2004.

The EEEV has never posed a significant human health threat to Florida residents or visitors. Between 1955 and 2013, 80 human EEEV cases were reported in 35 Florida counties. There have never been more than five human cases reported during a single transmission season in Florida and rarely is more than one human case reported from a county during a single year. Despite the availability of an efficacious equine vaccine against EEEV, positive horses are frequently reported in Florida. From 1982 through 2013, a total of 2,197 (mean of 69/year) EEEV positive horses were reported in the state. More than 150 EEEV positive horses were reported in Florida during 1982, 1991, 2003, and 2005. These recent (2003 and 2005) epizootics indicate that the Florida EEEV transmission cycle is still vigorously maintained and poses a continued threat to humans and equines in the state. As housing, industrial, and agricultural development encroaches into habitats that currently support the efficient maintenance and amplification of EEEV, the threat of focal human epidemic trans mission as well as the risk of continued widespread equine epizootics caused by EEEV remains a significant public health concern.

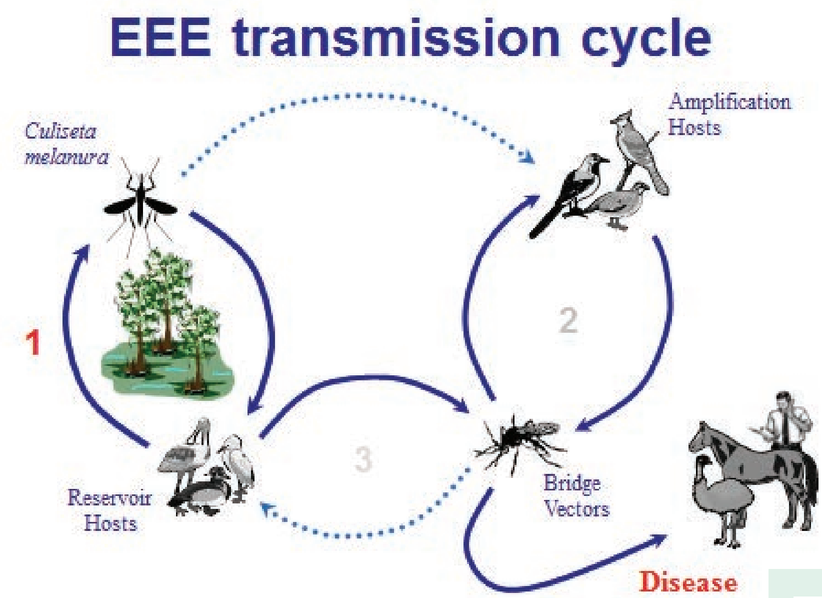



Figure 4. EEEV transmission cycle in Florida. The virus is maintained in freshwater swamps (1) where transmission likely occurs year round. During the Florida wet season, the virus disperses from the swamp habitat in infected vectors or avian amplification hosts (2), establishing secondary amplification foci in drier habitats outside of the swamp. Secondary (bridge) vectors become infected and transmit the virus to dead-end hosts, including humans and horses. During dry periods, infected mosquito vectors move back into swamp habitats (3), where they maintain the endemic transmission cycle.

*Jonathan F. Day, PhD is a Professor of Medical Entomology with the Florida Medical Entomology Laboratory and the Institute of Food & Agricultural Sciences at the University of Florida.*

# One Health in Action: Reducing Feral Swine Damage and Disease

Sarah Bevins, PhD and Alan Franklin, PhD

One Health is a philosophical approach to human, livestock, and wildlife disease that encompasses multiple disciplines, including the medical, veterinary and ecological sciences. As One Health becomes more widely embraced, examples of its practice can be found in government-sponsored programs. Recently, the U.S. Department of Agriculture announced a new Feral Swine Management Program that will be administered and implemented by the Animal Plant Health Inspection Service (APHIS) and will embody the tenets of One Health.

As an invasive species, feral swine (*Sus scrofa*) are a classic example of a species that can profoundly influence ecological communities and ecosystems. They alter environments through a suite of well-known traits: rooting behaviors that alter soil properties and disturb plant communities; a generalist diet that can encompass seeds, crops, and animals; a rapid reproduction rate that can result in explosive population growth; and an adaptable biology that allows them to thrive in a range of habitats and climates. Along with these more familiar traits of an aggressive invasive species, feral swine can also reservoir and transmit a host of pathogens, and because of this, pathogen monitoring and research will be an integral part of the Feral Swine Management Program. Feral swine have expanded their range from 17 to 39 states in the U.S. in the last 30 years, and a One Health approach is needed to manage the agricultural and human health implications of a rapidly expanding invasive species.

The primary problems associated with pathogens transmitted by feral swine are twofold. First, many of the pathogens are zoonotic and therefore represent a human health risk. People have been infected with multiple strains of *Brucella*, Hepatitis E, *Trichinella spiralis*, and leptospirosis from feral swine. In addition, swine are a mixing vessel for influenza viruses that allow different strains to recombine. Many of these recombinant strains have resulted in human pandemics. This threat is heightened because feral swine have unfettered contact with wild water birds which are the natural reservoirs for influenza viruses. Viral transmission among feral swine and water birds presents a potential for increased emergence of novel strains of influenza that could affect both agricultural and human health. Second, because feral swine and domestic swine are the same species, pathogens in feral swine pose a risk to the domestic swine industry. Swine brucellosis and pseudorabies are examples of pathogens that have essentially been eradicated in the U.S. domestic swine industry, but both still currently circulate in feral swine populations throughout the U.S. Pseudorabies can also be transmitted to other domestic animal and wildlife species, where it can cause substantial morbidity and mortality.

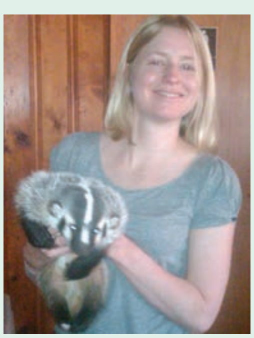
Another threat posed by feral swine is the introduction and spread of foreign animal diseases (FADs) in the U.S. These pathogens are not currently found in this country, but if pathogens which are infectious to swine are accidentally or intentionally introduced, feral swine could act as an unmonitored reservoir and create an enormous risk of exposure and infection to commercial herds. Classical swine fever is an example of an FAD that, if introduced to the U.S. domestic swine industry, could cause severe economic losses because of trade restrictions and loss of stock.

Feral swine settling in with a herd of cattle in Missouri.
Photo Credit: USDA: APHIS: Wildlife Services

The APHIS Feral Swine Damage Management Program will be the first nationally-led effort to reduce the expansion of this invasive species and to limit damage and pathogen transmission associated with feral swine. This program will focus on removing feral swine from multiple regions, including areas where there are isolated pockets of feral swine that can be eliminated, areas along the margins of feral swine distribution to stem population expansion, and areas with long-standing feral swine populations that could benefit from limiting population growth.

The eradication effort by USDA APHIS will establish procedures for disease monitoring. This effort will include developing new vaccination methods and conducting research and economic analyses to improve control practices, in addition to physically removing feral swine from the U.S. Multiple branches of USDA APHIS will be involved in this effort, including Wildlife Services, Veterinary Services, and International Services. Wildlife Services, with expertise in wildlife management and ecology, will provide the actual operative eradication programs and will also conduct research and pathogen monitoring through the National Wildlife Research Center (NWRC). Wildlife biologists, ecologists, geneticists, veterinarians, microbiologists, quantitative modelers, and economists will collaborate to efficiently meet the goals of the eradication effort. Veterinary Services will spearhead the diagnostic efforts for pathogens of concern, especially those of paramount concern for agricultural health. Samples from feral swine will be screened for five primary pathogens that threaten human and domestic animal health, including porcine reproductive and respiratory syndrome (PRRS), *Brucella* spp., pseudorabies, influenza A viruses, and classical swine fever. In addition to the five pathogens that will be monitored by the Feral Swine Management Program, data will continue to be collected on other pathogens as well, including leptospirosis, *Trichinella spiralis*, and *Toxoplasma gondii*. These samples will build upon an existing feral swine pathogen dataset that has been compiled by the NWRC National Wildlife Disease Program over the last seven years.

Disease issues associated with feral swine, because of their connection to zoonotic and domestic animal infections, require a One Health approach. This national effort proposes to eliminate feral swine from two states every 3-5 years and will attempt to stabilize feral swine damage across the U.S. within 10 years. Achieving this lofty goal will require a multi-disciplinary effort that includes expertise from the separate disciplines that define One Health.

*Sarah Bevins, Ph.D., is a Research Biologist at the USDA-APHIS-WS National Wildlife Research Center in Fort Collins, Colorado. Her research centers on the role of wildlife in pathogen systems.*

*Alan B. Franklin, Ph.D., is a Research Biologist and Project Leader of the Wildlife Pathogens and Food Security & Safety Project at the USDA-APHIS-WS National Wildlife Research Center in Fort Collins, Colorado.*

# An Analysis of the Linkages Between Public Health and Ecosystem Integrity Part 3 of 6

Steven A. Osofsky, DVM and Anila Jacob, MD, MPH

Health & Ecosystems: Analysis of Linkages (HEAL) is a consortium of more than 25 institutions collaborating to analyze and quantify relationships between the state of ecosystems and public health. The consortium comprises many of the world's premier public health and environmental science institutions working in both developing and developed countries. HEAL's mission is to increase support for integrated public health and environmental conservation initiatives as intimately related, interdependent challenges. A cross-sectoral attitudinal change will ultimately help to improve public health outcomes, equity, and resilience for some of the world's poorest people, often living in the world's most remote areas, while simultaneously conserving some of the most important natural landscapes and seascapes left on earth. It is a mission directly aligned with that of One Health (Barrett and Osofsky, 2013).

The HEAL consortium believes that there are important public health impacts associated with changes in the state of different ecosystems and that, frequently, degradation of these ecosystems leads to negative public health consequences. However, relatively little peer-reviewed literature delves into the mechanisms underlying potential causal relationships between ecosystem degradation and public health outcomes. Policy-makers interested in understanding these relationships are left with largely anecdotal information that is clearly insufficient for informing decision-making in terms of conservation, public health, or both.

A key component of HEAL's approach is to explore what is currently known regarding linkages between human health and natural ecosystems, as a foundation for prospective applied research. In this 6-part series, we are exploring what is currently understood in terms of linkages between the state of various ecosystems and major public health challenges. We focused on communicable diseases in the Fall 2013 issue of the One Health Newsletter and non-communicable diseases in the Winter 2014 issue. In this issue, we focus on the effect of ecosystem degradation on nutrition. In future issues we will tackle the connections between ecosystems and mental health, the loss of biopharmaceuticals, and vulnerability to extreme events.

Photo Credit: Mike Kock, Wildlife Conservation Society

**Currently Understood Linkage #3: Ecosystem degradation, food security, and nutrition**

Ecosystem integrity is critical to ensuring food security and preventing malnutrition, particularly in devel-oping countries (Richardson 2010). Malnutrition, including protein-energy malnutrition (also referred to as under-nutrition) and micronutrient deficiencies, impacts over two billion people globally and is a major cause of mortality and morbidity in developing countries, especially among children (Ahmed et al.2012). The United Nations World Food Program (UNWFP) estimates that almost 900 million people worldwide do not have access to adequate amounts of food to meet basic nutritional requirements; almost all of them live in low- or middle-income countries (UNWFP 2013a). At least two billion people suffer from micronutrient deficiencies globally (Tulchinsky 2010). Children who suffer from malnutrition have impaired growth and cognitive development and are often unable to reach their full potential. Adults who are undernourished may have difficulty working and earning a livelihood resulting in long-term impacts on household economic status (Ahmed et al. 2012, Grover and Ee 2009). Overall, countries with high rates of chronic malnutrition may face decreased economic productivity and growth.

The three primary aspects of food security include the availability of sufficient quantities of food, access to food, and the utilization of available food in a manner that meets nutritional requirements; stability is often included as a fourth aspect and refers to the access to food at all times including during crises. Each of these is determined by a number of factors including economic, social, and environmental conditions as well as population dynamics, among others (Richardson 2010, UNEP 2012b). All four aspects of food security are integral to improving and sustaining food security for the two billion people who currently suffer from malnutrition globally.


Photo Credit: Chris Golden

Intact ecosystems are critically important to each of the primary aspects of food security through a number of mechanisms. For example, natural systems ensure food availability by providing sufficient quantities of water and soil for agricultural production, regulating climate, providing wild foods from terrestrial ecosys-tems, yielding fish and other seafood from marine and freshwater ecosystems, preventing soil erosion, and providing pollination, natural fertilizers and pest control. The world's rural poor are most directly dependent on intact ecosystems to provide the goods and services that are critical for ensuring food availability (Richardson 2010).

Access to food is determined by a number of social, cultural, and economic factors; food prices and availability of resources to purchase food are particularly important determinants for poorer households. Natural systems are integral in ensuring food access by providing livelihoods and household income for millions of people in developing countries through the harvesting of natural products such as fish, bushmeat, fuelwood, and non-timber forest products (NTFPs). In sub-Saharan Africa, research has shown that the sale of NTFPs can provide up to 75% of household income for certain communities; the share of household income derived from the sale of these products was particularly significant for the poor (Richardson 2010).

The third aspect of food security, utilization, is determined by the way food is cleaned and prepared, the nutritional composition and diversity of food, and the distribution of food among members of a household. Intact ecosystems provide the water and biomass, such as fuelwood, to clean and cook food adequately. It is estimated that about 80% of households in sub-Saharan Africa rely on biomass for cooking (Wessels et al. 2013), which pres-ents its own set of problems. Natural systems also provide diverse, nutrient-rich foods for household consump-tion including fish, bushmeat, wild plants, nuts, and fruits (Richardson 2010).

Photo Credit: Chris Golden

To read more about protein-energy malnutrition, please click here. Click here to learn more about micronutrient deficiencies.

It is imperative that we improve our understanding of the complex and dynamic impacts of ecosystem change on nutrition. HEAL's applied research program aims to address these critical knowledge gaps through rigorous scientific inquiry aimed at comprehensively characterizing how ecosystem change affects human health, in order to progress a science to policy to action agenda.

In the next issue of the One Health Newsletter, our fourth installment explores the linkages between ecosystem change and mental health.

*Steven A. Osofsky, DVM is the Executive Director of the Wildlife Conservation Society's Wildlife Health & Health Policy Program, overseeing all of their Global Conservation Program's work in the health realm. He is also an adjunct assistant professor at the University of Maryland, College Park. Steve launched the Health & Ecosystems: Analysis of Linkages (HEAL) program.*

*Anila Jacob, MD is an internal medicine physician with an MPH in Global Environmental Health. Currently she is a senior technical expert at ICF International, where she works on the Measuring Impact project with USAID's Forestry and Biodiversity Office.*

# Graduate-level Certificate in One Health Training at the University of Florida

Marissa A. Valentine-King, MPH, RN

In early May of each year, 30 to 40 international public and veterinary health professionals, hailing from a diverse range of countries such as Egypt, Bangladesh, Peru and China, gather in Gainesville, Florida to participate in a unique training program. This graduate-level Certificate in One Health (COH) program began in 2008 as the Certificate in Emerging Infectious Disease Research (CEIDR). In 2013, the curriculum and program focus shifted to further emphasize the One Health approach to environmental, veterinary, and public health issues.

Trainees from Romania, Egypt, Nigeria, Georgia, and Mongolia develop a response plan to a hypothetical disease outbreak during an in-class exercise. Photo by Mary Merrill

The COH program began in response to the emergence of several complicated, global infectious diseases such as Severe Acute Respiratory Syndrome (SARS), West Nile virus, and zoonotic influenza viruses, and sought to engage and train international public health scientists to better respond to emerging infectious disease (EID) threats. Over the years, the program has received combined supported from the Armed Forces Health Surveillance Center's Global Emerging Infections Surveillance and Response (AFHSC-GEIS), the State Department's Biological Engagement Program, the US Centers for Disease Control and Prevention, the National Institutes of Health, and from self-funded, individual trainees.

The COH program engages professionals through an intensive, 18-day curriculum at UF that includes coursework in One Health problem solving, public health laboratory techniques, entomology, zoonotic diseases, and food safety. This instruction offers a combination of didactic training, small group problem solving, laboratory training, and fieldwork. Highlights of the COH program include visiting the Austin Cary Forest to trap and identify mosquitos and ticks, touring multiple modern food production plants, visiting the Florida Department of Agriculture and Consumer Services Laboratory, and hands-on laboratory training in respiratory virology. Following the on-campus courses, students complete an Environmental Health Concepts course using a distance-learning format to complete their certificate training.

Trainees from China and Yemen perform PCR for identification of influenza virus during the public health lab techniques course. Photo by Greg Gray

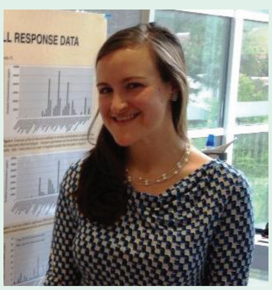
In addition to laying the groundwork for One Health expertise in students, the program aims to expose students to international professionals sharing similar goals to establish connections and collaborate in future One Health-related projects. This setting allows students to learn outside the classroom about public health issues in other countries and current challenges and solutions in place. Thus, COH students leave Gainesville not only with

Trainees from Nigeria dentify mosquito adults and larvae during the entomology field day.
Photo by Mary Merrill

recognition of international One Health issues, but also with an international network of public and veterinary health professionals.

In closing, we restate some of Dr. Jose Sanchez' (sponsor from AFHSC-GEIS) thoughts regarding how UF's COH program aligns with priorities for the US military: "Capacity building and electronic surveillance initiatives are crucial to the implementation of the WHO's 2005 International Health Regulations (IHR). Compliance with these initiatives is achieved by: 1) enhancing host country laboratory and epidemiologic expertise; 2) providing needed diagnostic technical capacity; 3) leveraging existing USG-supported EID surveillance and research initiatives; and 4) facilitating the establishment of laboratory-based and/or syndromic-based surveillance systems. All these initiatives are geared towards enabling individual nations to meet IHR core capacities, and the Global Health Security Agenda's objectives of early detection, prevention and response to EID threats and epidemics.

More information on the program can be found at UF's One Health Center of Excellence website: [http://epi.ufl.edu/onehealth/training-programs](http://epi.ufl.edu/onehealth/training-programs).



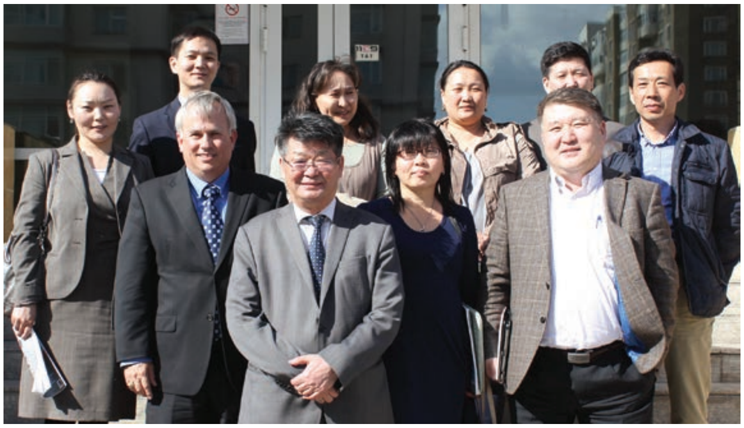

*Marissa A. Valentine-King, MPH, RN is a One Health PhD student and Graduate Assistant in the Department of Environmental & Global Health, College of Public Health & Health Professions at the University of Florida.*

Dragging for ticks in Austin Cary Forest during the entomology field day. Photo by Mary Merrill

# One Health Innovation Fellowships for Zoonotic Disease Research in Mongolia

Salah Uddin Khan, DVM

The One Health Innovation Fellowship for Zoonotic Disease Research in Mongolia was designed to provide structured research training in the control of zoonotic infections in Mongolia. This United States-Mongolia multidisciplinary partnership engages the Mongolian Academy of Medical Sciences, the Health Science University of Mongolia, and the Institute of Veterinary Medicine, each in Ulaanbaatar, Mongolia along with the University of Florida. Professor Gregory Gray of the University of Florida serves as the United States Principal Investigator (PI) and Professor Pagbajabyn Nymadawa serves as the site PI for Mongolia. The fellowship is funded by the National Institutes of Health Fogarty International Center.



Collaborators from Mongolia and the United States of America meet in Ulaanbaatar, Mongolia to discuss plans for the fellowship.

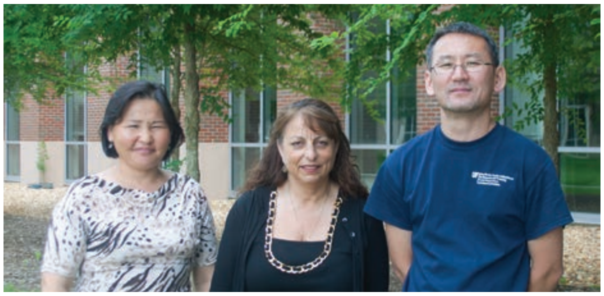
In recent decades, Mongolia has experienced major economic and environmental changes, and suffered many large epidemics of zoonotic diseases. This fellowship has four specific aims to address these issues: first, to identify the risks and conditions that are associated with zoonotic disease morbidity in Mongolia; second, to employ modern technologies available at the University of Florida, and by using a multidisciplinary team approach, apply these technologies towards controlling specific zoonotic disease problems in Mongolia; third, to follow a train-the-trainer approach and transfer these zoonotic control techniques to regional public health and animal health professionals throughout Mongolia; and fourth, to translate scientific findings into prevention practices or products that will help reduce zoonotic disease morbidity and mortality among pastoral people worldwide.

Each year teams of 3 United States and Mongolian postdoctoral fellows will undergo two years of this research training. The host institutes have identified vector-borne infections as the key research focus. The focus was set based on the public health priorities in Mongolia. Three postdoctoral fellows, two from Mongolia and one from the United States, have been selected for the 2014-2016 fellowship and are currently at the University of Florida for two months, exploring One Health approaches and technical resources for developing innovative technologies, products, policies, and training. This provides them the opportunity to identify appropriate tools to design research studies to address issues involving the focused public health priority research areas in Mongolia. The team of fellows will spend roughly 18 months in Mongolia to implement their research study.

Dr. Boldbaatar Bazartseren, one of the postdoctoral fellows, presents preliminary research ideas to an audience of research professionals at the University of Florida in June of 2014. Photo by Greg Gray

The fellowship provides a unique opportunity to translate One Health research approaches into methods. This requires the fellows to seek innovative tools and approaches to design a study, while scholars from the collaborating Mongolia and United States institutions provide specific feedback and guidance.

The long term goal of this fellowship is to develop a global health training program that elicits innovative, multi-disciplinary team problem-solving solutions to develop products, alter disease processes, and guide policies in controlling zoonotic diseases in low- or middle- income countries. In this effort, the team will employ One Health cross-disciplinary training and foster collaborations in public, veterinary, and environmental health sectors.



One Health Innovation postdoctoral fellows, from left to right: Lkhagvatseren Sukhbaatar, DVM, PhD (Mongolia), Sophia Papageorgiou, DVM, MPVM, PhD (USA), and Boldbaatar Bazartseren, DVM, PhD (Mongolia)

*Salah Uddin Khan, DVM is a One Health PhD student and Graduate Assistant in the Department of Environmental & Global Health, College of Public Health & Health Professions at the University of Florida.*

# ProMED Quarterly Update - Camels, bird flu, & Ebola

Jack Woodall, PhD

*This review covers selected reports posted on the ProMED-mail website and to 60,000 free subscribers by e-mail <www.promedmail.org> during the quarter March though May 2014.*

Remember SARS (Severe Acute Respiratory Symptom), caused by a new human virus first seen in Hong Kong, that spread around the world? Between November 2002 and July 2003, an outbreak of SARS in southern China caused an eventual 8,273 cases and 775 deaths reported in multiple countries with the majority of cases in Hong Kong. The fatality rate was 9.6% according to the World Health Organization (WHO). Within weeks, SARS spread from Hong Kong to infect individuals in 37 countries in early 2003.

The origin of SARS was traced to Chinese markets selling palm civets for food, their meat being a delicacy in parts of China. The pathogen was identified as a beta-coronavirus of a type also found in bats, from which the civets must have somehow become infected. When the civet trade was halted, and strict infection control procedures were followed in all hospitals receiving cases, the outbreak ended.

## MERS-CoV

The big news this quarter has been an outbreak which began in September 2013 of another severe respiratory disease, in Saudi Arabia and neighboring Arab countries, caused by a new human-pathogenic beta-coronavirus that has been named Middle Eastern Respiratory Syndrome coronavirus (MERS-CoV). Also presumptively of bat origin, this time the link to humans is the dromedary (one-humped) camel, ubiquitous in Arabia and impossible to completely avoid contact with – in Saudi Arabia the MoH has advised camel owners and handlers to wear masks and gloves around their animals and cooks to wear gloves when preparing

Dromedary camel
Photo by Jjron
Wikimedia Commons / CC-BY-SA-3.0

camel meat for cooking. Only a handful of cases of illness have been observed in camels, but tests on archived camel sera have shown high levels of previous infection in dromedaries in many countries going back 20 years.

Unpasteurized camel milk and urine are consumed as sovereign remedies in Arabia, prescribed in the Koran, and these may be implicated in transmission. Antibodies indicating previous infection with MERS-CoV have been found in camels in Africa (Egypt, Kenya), so human infection might be found there also.

On the last day of May it was reported that the first two cases in Africa had been diagnosed in Algeria in people returning from the Umrah pilgrimage in Saudi Arabia. The total number of laboratory confirmed cases of MERS-CoV infection in Saudi Arabia was then 571 including 189 deaths.

MERS-CoV has now been found in humans in 15 countries - 9 in the Middle East, as well as Algeria, Greece, Malaysia, the Netherlands, Philippines and the USA, as visitors to the Middle East have contracted the virus and returned to their home countries. With more than 600 confirmed laboratory cases of MERS-CoV, the death rate appears to be approx. 30%. Unfortunately, many cases and deaths have been doctors and health workers, highlighting the dire need to follow strict infection control procedures.

## Avian influenza

Human infections with new strains of avian flu are appearing, complicating the diagnosis of influenzas that too often lead to fatal pneumonias. Some are low pathogenic (LPAI), asymptomatic in poultry, so can only be detected by blind serological testing on farm or commercial flocks.

Chickens infected with H5N1, photo credit Reuters/Stringer

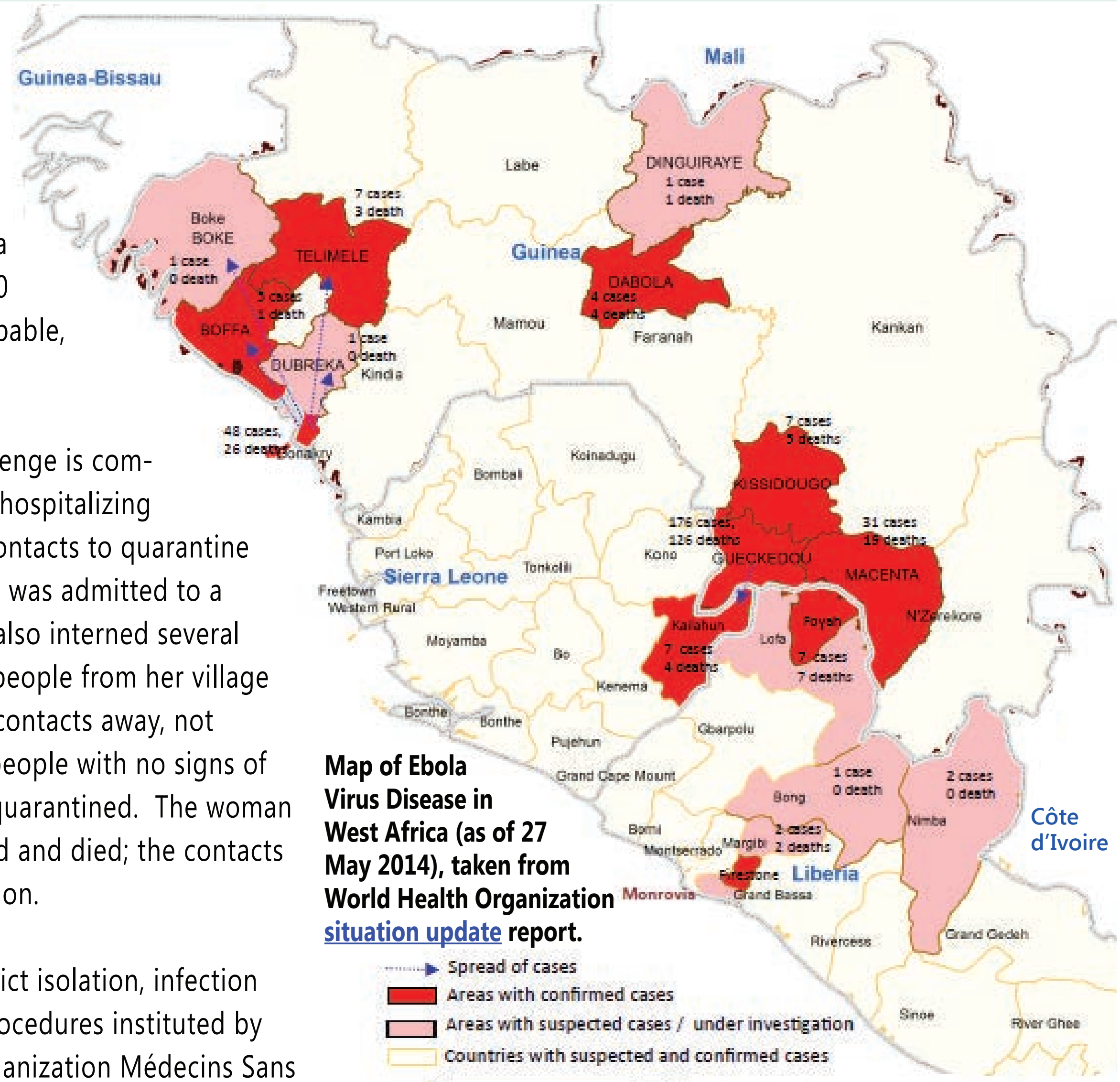
**Highly pathogenic avian flu (HPAI) H5N1** has sickened humans in Cambodia, Egypt and Indonesia.

**Low pathogenic avian flu (LPAI) H7N9** has reappeared in mainland China, affecting poultry and claiming an occasional human victim. The first human case of **LPAI H5N6 avian flu** (fatal) was reported from China by ProMED on 4 May 2014.

## Ebola

West Africa was hit by its first **Ebola virus disease (EVD)** outbreak in March this year, which as of 28 May 2014 had caused a cumulative total of 291 clinical cases (193 deaths) reported in Guinea (where it reached the capital, Conakry) and a total of 12 cases (9 deaths) reported in Liberia (where it reached close to the capital, Monrovia). There had been no new cases in Liberia since 9 Apr 2014, which should have placed the country out of danger, but a suspected new case appeared on 29 May.

Amazingly, EVD spared Sierra Leone (which is encircled by Guinea and Liberia and shares the same belt of tropical forest and fauna) until 26 May, apart from two inhabitants who attended the funeral of a countryman who had died across the border in Guinea, evidently of EVD. Funeral rites involved washing the body, which brought relatives into contact with the infectious blood and secretions of the victim. In April, a faith healer treated two sick people who had come across from Guinea. She and two members of her family died in May, retrospectively obviously from EVD, and a woman who attended her funeral came down with lab confirmed EVD and spread it around the area. As of 29 May the cumulative total number of clinical cases of EVD in Sierra Leone had risen to 50 (14 confirmed, 3 probable, and 33 suspected).




**Map of Ebola Virus Disease in West Africa (as of 27 May 2014), taken from World Health Organization situation update report.**

A major challenge is community resistance to hospitalizing apparently healthy contacts to quarantine them. The index case was admitted to a local hospital which also interned several of her contacts, but people from her village took her and all her contacts away, not understanding why people with no signs of bleeding should be quarantined. The woman was soon re-admitted and died; the contacts were under observation.

In Guinea, strict isolation, infection control and burial procedures instituted by the humanitarian organization Médecins Sans Frontières brought the outbreak apparently under control until the end of May when cases reappeared in Conakry and were said to have been exported back upcountry. The situation was no longer under control, and neighboring Senegal and Mali were instituting precautions. Unregulated cross-border social and commercial traffic make it difficult to control the spread.

The jungle hosts of ebolaviruses are fruit bats and possibly small antelopes and monkeys (the viruses are fatal to gorillas and chimpanzees). There are at least five different strains of ebolaviruses, and the one responsible for this outbreak was most closely related to EBOZ (ebolavirus- Zaire), found in the two Congos, suggesting that the forested areas of all sub-Saharan countries between Guinea and Cameroun may harbor that strain. Gambia and Mali are preparing for the worst. There is also much uncontrolled cross-border traffic between Côte d'Ivoire and Guinea, and Côte d'Ivoire has had a plan of action in place since mid-April.

As of 18:00 on 28 May 2014, WHO had reported a cumulative total of 291 clinical cases of EVD, including 193 deaths, in Guinea. The classification of these cases and deaths are as follows: confirmed, 172 cases and 108 deaths; probable, 71 cases and 62 deaths; and suspected, 48 cases and 23 deaths. The breakdown of cases and deaths by affected areas is as follows: Conakry, 53 cases and 27 deaths; Gueckedou, 179 cases and 133 deaths; Macenta, 40 cases and 23 deaths; other towns/villages, 16 cases including 10 deaths. These are all border areas in forest. Case numbers remain subject to change due to reclassification, retrospective investigation, consolidation of cases and laboratory data, and enhanced surveillance.


Ebola isolation unit. Photo via Reuters

## Animal outbreaks

***Streptococcus iniae*** was first described from an Amazon dolphin. Subsequently it was found in a variety of freshwater fish around the world, following which it was identified in marine fish. In February, an outbreak of *S. iniae* killed an estimated 10,000 fish of 83 species in the waters off the Indian Ocean island of Reunion. No human infections by this pathogen were reported, but when they do occur, they may cause cellulitis, endocarditis, meningitis, and arthritis.

**Highly pathogenic avian flu (HPAI) H5N1** has been killing chickens in Germany, Libya, Laos & North Korea). **HPAI H5N8** has been spreading in poultry in South Korea and Japan this quarter, carried by migratory birds, but so far no human infection has been reported.

**Low pathogenic avian flu (LPAI) H5N1** has been detected in the Netherlands. **LPAI H7N9**, innocuous to poultry but virulent in humans, has reappeared in both poultry and humans in China. **LPAI H5** (subtype not reported) killed a few Japanese quail on a poultry farm in California, USA, in April. As a result, all 95,000 adult quail on the premises were slated to be destroyed, following standard practice. **LPAI H5N2** was detected poultry in the Netherlands and Taiwan. **LPAI H5N6** was detected in China; **HPAI H5N6** killed poultry in Laos. **LPAI H7N3** was detected for the first time in Mexico, in a consignment of imported South American parakeets.

Pharmaceutical companies have no interest in producing vaccines for LPAI (low pathogenic avian flu) strains that do not cause significant productivity problems for commercial producers, even though they may kill people. But when an LPAI strain is detected, culling of the entire flock – which may consist of thousands of birds – is usually mandatory, for fear that the strain might mutate and become virulent for humans.

**Foot-and-mouth disease** has been spreading in Africa (Guinea, Tunisia & Zimbabwe) and Asia (China, North Korea, the Far East of Russia & Viet Nam).

**Porcine epidemic diarrhea** is a new disease that appeared in the USA in May 2013, caused by a novel enteric corona virus of swine. It spread to Canada in April 2014.

**African swine fever** has been spread by wild boar from Russia into Eastern Europe and is presenting a serious threat to the pig industry. A proposal to build an EU-financed fence across the Polish border to stop its southern spread was too little, too late (and in any case impractical).

## Plant outbreaks

Food plant pathogens continued their spread largely unchecked, affecting major food and animal feed crops. The breeders of disease resistant strains of wheat, rice and potatoes are having a hard time keeping up with the appearance of new strains of pathogens such as TR-4 (Tropical Race 4) of Panama disease of bananas.

*Phytothphora infestans*, the pathogen called "late blight" responsible for the great Irish potato famine of 1845-1850, is making a comeback in Bangladesh and Canada.

**First reports** were posted of corn cyst nematode in maize in Afghanistan; Moko disease in banana in Malaysia; plum pox virus in Israel; and little cherry disease in Australia, all in March. Maize and bananas are essential staple foods in some parts of the world.

For more on these and other outbreaks, please go to www.promedmail.org. Click on the Hot Topics tab, or click the Search tab to enter a keyword and date limits.

*Jack Woodall, PhD, is Co-founder and Associate Editor of ProMED-mail. He is also a member of the One Health Initiative team.*

# Advancements in One Health

## FDA Partners with Veterinary Labs to Help Animals

Renate Reimschuessel, a research biologist with the FDA started the Veterinary Laboratory Investigation and Response Network (Vet-LIRN), originally known as the Veterinary Laboratory Response Network (Vet-LRN) in 2011. Vet-LIRN is a partnership between federal, state, and university veterinary laboratories to investigate consumer concerns regarding harm to animals via animal food or medicines. Dr. Reimschuessel started the program after her involvement in the 2007 contamination of pet food with melamine and cyanuric acid. She saw a need for the FDA to connect with state and university laboratories to share knowledge and information. She modeled her program after the Food Emergency Response Network. Vet-LIRN is funded by the FDA's Center for Veterinary Medicine and is able to provide grants to their partnering laboratories. The FDA now works with 34 state and university laboratories across the United States.

For more information on this partnership please see the following FDA links: How Vet-LIRN was created and Vet-LIRN homepage.

## West Central Florida Medical Reserve Corps nationally recognized with Public Health Innovator Award for One Health Efforts

The Florida Department of Health in Pasco County's West Central Florida Medical Reserve Corps (WCFMRC) has received the Public Health Innovator Award for their One Health efforts last June. The Division of the Civilian Volunteer Medical Reserve Corps determines recipients of the Public Health Innovator Award as well as other award categories after nominations are reviewed from across the Country. Dr. Jenifer Chatfield, president of the Pasco Hernando Veterinary Medical Association (PHVMA) nominated the WCFMRC for their work in Pasco County. The WCFMRC was selected as the award recipient for their innovative partnerships in One Health. Pasco County's WCFMRC partnered with the PHVMA and the Public Defender's Mobile Medical Unit (MMU) to provide a One Health Mobile Medical Unit (the first in the state of Florida). This One Health MMU targeted the

# Advancements in One Health (Continued)

homeless population in Pasco County by providing them with medical care, legal services outreach, and veterinary care for their companion animals.

Dr. Chatfield reflects on the value of the MMU, "Many Homeless people in Pasco have companion animals. Without routine appropriate preventative veterinary care, the animals could serve as a source of zoonotic disease to their owners and others in the vulnerable homeless population. Additionally, conversations about pet care can frequently serve as "gateway" conversations to address personal health care issues."

To read more on the One Health Mobile Medical Unit please see Volume 6 Issue 3 of the One Health Newsletter publication. The article displaying this amazing One Health collaboration is on the bottom of page 8 titled, "One Health Approach to a Mobile Medical Unit in Pasco County, Florida."

## Missouri State Medical Association becomes the third in the USA to adopt One Health Resolution

*[originally printed on the OHI website (onehealthinitiative.com)]*

The Missouri State Medical Association became the third state medical society in the United States to adopt a One Health Resolution. Florida was the first followed by Massachusetts. Missouri Medicine published a One Health Issue of their medical journal for May/June 2013. The issue can be accessed here.

For more information the Missouri Medicine medical journal editor, Dr. John C. Hagan, can be reached at jhagan@bizkc.rr.com.

# Upcoming Events

**Second Annual One Health International Symposium**
Liverpool, England June 19-21, 2014
http://onehealth.uga.edu/symposium

**SEA-EU-NET One Health Master Class Fellowship**
**Deadline for Applications** June 27, 2014
Visit http://www.sea-eu.net/ for more details.

**63rd Annual International Conference of the Wildlife Disease Association**
Tamaya Hyatt, Albuquerque, New Mexico July 27- August 1, 2014
Conference theme: "One Health: Transitioning from Theory to Practice"
http://www.wildlifedisease.org/wda/CONFERENCES/AnnualInternationalConference.aspx

**EcoHealth: The 5th Biennial Conference of the International Association for Ecology & Health**
Montreal, Canada August 12-15, 2014
http://ecohealth2014.uqam.ca/en.html

**One Health Symposium**
UC Davis, Davis, California August 24, 2014
Live webinar also available
http://www.vetmed.ucdavis.edu/ce/one_health/one_health_symposium.cfm

**One Health International Conference**
University of Peradeniya, Peradeniya, Sri Lanka September 5-6, 2014
http://www.pdn.ac.lk/ic/ohic/

**World Association for History of Veterinary Medicine Meeting**
Imperial College, London, England September 10-13, 2014
http://www.veterinaryhistorylondon.com/

**3rd Global Risk Forum One Health Summit**
Davos, Switzerland October 5-8, 2014
http://onehealth.grforum.org/home/

**International Symposium for One Health Research**
Guangzhou, Guangdong, China November 22-23, 2014
***Abstract deadline: October 20, 2014***
http://onehealth.csp.escience.cn/dct/page/1

**3rd International One Health Congress**
Amsterdam, the Netherlands March 15-18, 2015
http://www.iohc2015.com/

# Recent Publications in One Health

## Journal Articles

**One Health approach to Rift Valley fever vaccine development**. J. Kortekaas. Antiviral Research. June 2014. 106:24-32.
http://www.sciencedirect.com/science/article/pii/S0166354214000825

**Emerging infectious diseases: Opportunities at the human-animal-environment interface.** M.A. Dixon, O.A. Dar, D.L. Heymann. Veterinary Record. June 2014. 174(22):546-551.
http://veterinaryrecord.bmj.com/content/174/22/546.full

**Seeing the forest for the trees: how "one health" connects humans, animals, and ecosystems.** W. Nicole. Environmental Health Perspectives. May 2014. 122(5):A122-9.
http://ehp.niehs.nih.gov/122-a122/?utm_source=rss&utm_medium=rss&utm_campaign=122-a122

**One Health: Past successes and future challenges in three African contexts.** A.L. Okello, K. Bardosh, J. Smith, S.C. Welburn. PLoS Neglected Tropical Diseases. May 2014. 8(5):e2884.
http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0002884

### Journals Featuring One Health Manuscripts

**Veterinary Record Journal**
(http://veterinaryrecord.bmj.com/)
During 2014, featured articles will present the concept of One Health, including current issues, history or future challenges.

**Infection Ecology & Epidemiology: The One Health Journal**
(http://www.infectionecologyandepidemiology.net/index.php/iee)
This One Health journal features original research articles, review articles, or other scientific contributions in One Health, that motivate interdisciplinary collaborations between researchers in various clinical and environmental health disciplines.

**Toward One Health: Are public health stakeholders aware of the field of animal health?** F.C. Dórea, C. Dupuy, F. Vial, T.L. Reynolds, et al. Infection Ecology & Epidemiology. April 2014. 4.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3991838/?report=classic

**Dances with anthrax: Wolves (Canis lupus) kill anthrax bacteremic plains bison (Bison bison bison) in southwestern Montana.** J.K. Blackburn, V. Asher, S. Stokke, D.L. Hunter, et al. Journal of Wildlife Diseases. April 2014. 50(2):393-396.
http://www.jwildlifedis.org/doi/pdf/10.7589/2013-08-204

**Detection of elephant endotheliotropic herpesvirus infection among healthy Asian elephants (Elephas maximus) in south India.** J.J. Stanton, S.A. Nofs, A. Zachariah, N. Kalaivannan, et al. Journal of Wildlife Diseases. April 2014. 50(2):279-287.
http://www.jwildlifedis.org/doi/full/10.7589/2012-09-236

**Evidence of psittacine beak and feather disease virus spillover into wild critically endangered orange-bellied parrots (Neophema chrysogaster).** A. Peters, E.I. Patterson, B.G. Baker, M. Holdsworth, et al. Journal of Wildlife Diseases. April 2014. 50(2):288-296.
http://www.jwildlifedis.org/doi/abs/10.7589/2013-05-121?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%3dpubmed

**Severe hoof disease in free-ranging Roosevelt elk (Cervus elaphus roosevelti) in southwestern Washington, USA.** S. Han, K.G. Mansfield. Journal of Wildlife Diseases. April 2014. 50(2):259-270. http://www.ncbi.nlm.nih.gov/pubmed/24484504

**A rapid field test for sylvatic plague exposure in wild animals.** R. Abbott, R. Hudak, R. Mondesire, L.A. Baeten, et al. Journal of Wildlife Diseases. April 2014. 50(2):384-388.
http://www.ncbi.nlm.nih.gov/pubmed/24484483

# Recent Publications (continued)

**The seal tuberculosis agent, Mycobacterium pinnipedii, infects domestic cattle in New Zealand: Epidemiologic factors and DNA strain typing.** S.H. Loeffler, G.W. de Lisle, M.A. Neill, D.M. Collins, et al. Journal of Wildlife Diseases. April 2014. 50(2):180-187.
http://www.ncbi.nlm.nih.gov/pubmed/24484478

**Policies on pets for healthy cities: A conceptual framework.** M.J. Rock, C.L. Adams, C. Degeling, A. Massolo, et al. Health Promotion International. April 2014. (Epub ahead of print)
http://www.ncbi.nlm.nih.gov/pubmed/24694682

**A One Health approach to the control of zoonotic vectorborne pathogens.** C. Oura. Veterinary Record. April 2014. 174(16):398-402.
http://veterinaryrecord.bmj.com/content/174/16/398.abstract

**Animal-assisted interventions: Making better use of the human-animal bond.** D. Mills, S. Hall. Veterinary Record. March 2014. 174(11):269-273.
http://veterinaryrecord.bmj.com/content/174/11/269.full

**One-Health simulation modelling: A case study of influenza spread between human and swine populations using NAADSM.** S. Dorjee, C.W. Revie, Z. Poljak, W.B. McNab, et al. Transbound Emerging Diseases. March 2014. (Epub ahead of print)
http://www.ncbi.nlm.nih.gov/pubmed/24661802

**People, pets, and parasites: One Health surveillance in southeastern Saskatchewan.** J.M. Schurer, M. Ndao, H. Quewezance, S.A. Elmore, et al. American Journal of Tropical Medicine and Hygiene. March 2014. (Epub ahead of print)
http://www.ncbi.nlm.nih.gov/pubmed/24639298

**Preventing and controlling zoonotic tuberculosis: A One Health approach.** J.B. Kaneene, R. Miller, J.H. Steele, C.O. Thoen. Veterinaria Italiana. January-March 2014. 50(1):7-22.
http://www.ncbi.nlm.nih.gov/pubmed/24715597

**Making One Health a reality – crossing bureaucratic boundaries.** C. Rubin, B. Dunham, J. Sleeman. Microbiology Spectrum. January 2014. 2(1):OH-0016-2012. doi:10.1128/microbiolspec.OH-0016-2012
http://ohcea.org/wp-content/uploads/2014/03/Making-One-Health-a-Reality-Crossing-Bureaucratic-Boundaries-Rubin-et-al-MicrobiolSpectrum-Feb2014.pdf

## Proceedings of the 2nd One Health Conference in Africa.

View the full proceedings of the 2nd One Health Conference in Africa, published by the open access Onderstepoort Journal of Veterinary Research at the following link:
http://www.ojvr.org/index.php/ojvr/issue/view/37

To learn more about the 2nd One Health Conference in Africa, visit the following link:
http://www.sacids.org/kms/frontend/index.php?m=119

# Article References

## The Natural History of Eastern Equine Encephalomyelitis Virus in Florida

Arrigo NC, Adams AP, Weaver SC. Evolutionary patterns of eastern equine encephalitis virus in North versus South America suggest ecological differences and taxonomic revision. J Virology. 2010;84(2):1014-1025.

Day JF, and Curtis GA. When it rains, they soar—and that makes Culex nigripalpus a dangerous mosquito. American Entomologist. 1994;40:162-167.

Day JF, and Stark LM. Transmission patterns of St. Louis encephalitis and eastern equine encephalitis viruses in Florida: 1978-1993. J Med Entomol. 1996;33:132-139.

Day JF, and Stark LM. Eastern equine encephalitis transmission to emus (Dromaius novaehollandiae) in Volusia County, Florida: 1992 through 1994. J Am Mosq Cont Assoc. 1996;12:429-436.

Hanson RP. An epizootic of equine encephalomyelitis that occurred in Massachusetts in 1831. Am J Trop Med Hyg. 1957;6:558-862.

Scott TW, Weaver SC. Eastern equine encephalomyelitis virus: epidemiology and evolution of mosquito transmission. Advances in Virus Res. 1989;37:277-328.

## An Analysis of the Linkages Between Public Health and Ecosystem Integrity Part 3 of 6

Ahmed T, Hossain M, Sanin KI. Global burden of maternal and child undernutrition and micronutrient deficiencies. Ann. Nutr. Metab. 2012; 61(suppl 1):8-17.

Barrett MA, Osofsky SA. One Health: Interdependence of People, Other Species, and the Planet. In: Katz DL, Elmore JG, Wild DMG, Lucan SC, editors. Jekel's Epidemiology, Biostatistics, Preventive Medicine, and Public Health (4th ed.). Philadelphia: Elsevier/Saunders; 2013. pp. 364-377 and online supplement pp. 407(e1)-416(e10).

Grover Z, Ee LC. Protein energy malnutrition. Pediatr. Clin. North Am. 2009; 56(5):1055-68.

Richardson RB. Ecosystem services and food security: economic perspectives on environmental sustainability. Sustainabil ity 2010; 2:3520-48.

Tulchinsky T. Micronutrient deficiency conditions: global health issues. Public Health Reviews 2010; 32:243-255.

United Nations Environment Programme (UNEP) [Internet]. Geneva, Switzerland. Avoiding Future Famines: Strengthening the Ecological Foundation of Food Security; 2012b [Cited 2013, April 2].

United Nations World Food Programme (UNWFP). [Internet]. Rome, Italy. Hunger stats; 2013a [Cited 2013, Feb 28].

Wessels KJ, Colgan MS, Erasmus BFN, Asner AP, Twine WC, Mathieu R, van Aardt JAN, Fisher JT, Smit IPJ. Unsustainable fuelwood extraction from South African savannas 2013; 8(1):4007-16.