DoD Medical Entomologist Resources
September 2020

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Military Entomology

Entomologists – Roles and Responsibilities

DoD military

Develops and administers medical entomology and pest management programs. Formulates policies, plans and procedures for all medical entomology aspects of military public health programs, with emphasis upon epidemiology, surveillance, evaluation, and management procedures. Provides instruction in collection, handling, identification, prevention, and control of disease associated with arthropods. Advises all levels of military capabilities and programs for prevention or control of arthropod and other animal-associated disease.

Develops and administers pest management programs. Formulates polices, plans, and procedures. Ensures that pest management operations do not present unacceptable risks to human health and the environment. Ensures adequate pest management in contingency, humanitarian assistance and disaster relief operations. Resolves technical problems in all aspects of pest management, such as pest biology, control measures, pesticides, and pest control equipment. Formulated integrated pest management plans and provides integrated pest management technology transfer to the field. Determines pest management certification and training requirements and assists in pest management curriculum development. Acquires, manages, and reports pest management data base.

Conducts surveys of animals associated with disease and recommends control measures. Selects survey sites and modifies materials and equipment based on habits of animals concerned. Installs traps to collect animals, classifies collections, and determines the significance and medical importance of the populations. Assesses measures required for prevention, control, or eradication of arthropod pests and vectors and other animals known to affect the health and morale of personnel. Performs studies in support of environmental impact and assessment preparation.

Conducts entomology, vector control and pest management research. Leads or participates in laboratory and field studies concerning bionomics, distribution and host associations of arthropods and other animals of known medical or pest importance. Investigates relationship of environment of disease-associated animals. Collects, compiles, and evaluates data on to the development of animal control measures. Develops and tests effectiveness of pesticides and distribution systems.

Coordinates pest management and medical biologic activities with military and civilian agencies. Maintains close coordination with DoD medical entomologists, pest managers, and related professionals. Maintains liaison with municipal authorities, public health organizations, and other federal agencies concerning control of diseases or infections transmitted by animals prevalent in off-base areas to which military personnel are exposed. Attends and participates in meetings of professional societies and associations.

Air Force – Additional Duties
-All of the above
-Provide large area, fixed-winged, aerial pesticide application to control disease vectors, pest organisms and vegetation during DoD and DoD supported operations
-Serve as Air Force Public Health Officers applying public health and preventative medicine knowledge, techniques, and skills to promote health and reduce the incidence of communicable and zoonotic diseases, occupational and environmental illnesses and injuries, food borne diseases, and disease and non-battle injuries while in garrison as well as in field conditions. Promotes public health through epidemiological surveillance of health and disease trends in populations, as well as monitoring food safety practices, and sanitation levels in public and food service facilities

Navy – Additional Duties
-All of the above
-Provide shipboard pest management program guidance and support. Provide training to Navy personnel responsible for shipboard pest management programs

DoD Civilian
Develops, implement and supervise comprehensive installation/location integrated vector- and pest-management programs. Participates in the development and/or evaluation of pesticides, pest management equipment and techniques. Conducts research on vector-borne diseases, including the physiology, bionomics and taxonomy of medically important arthropods. Provides instruction to civilian and military personnel

Current Active Duty Manning

Component	Military Entomologist (Medical Service Corps)	Military Public Health Officer/Entomologist (Biomedical Science Corps)	Preventive Medicine Technician (8432)	Preventive Medicine Specialist (68S)	Pest Management Specialist (3E4X3)
Army	58 (Sub specialty 72B)			702	
Navy	41 (Sub specialty 1860)		696		
Air Force		12 (Sub specialty 43H3E)			208

Duty Stations

Army	Navy	Air Force *	DLA
Armed Forces Pest Management Board, Silver Spring, MD	Armed Forces Pest Management Board, Silver Spring, MD	Armed Forces Pest Management Board, Silver Spring, MD	Command Entomologist, Fort Belvoir, VA
Walter Reed Army Institute of Research, Silver Spring, MD	Navy Entomology Center of Excellence, Jacksonville, FL	Malmstrom Air Force Base, MT	
Walter Reed Army Biosystematics Unit, Washington, DC	Navy and Marine Corps Public Health Center, Portsmouth, VA	Kadena Air Base, Japan	
United States Army Medical Research Institute of Infectious Diseases, FT Detrick, MD	Navy Environmental and Preventive Medicine Unit 2, Norfolk, VA	Wright-Patterson Air Force Base, OH	
Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand	Navy Environmental and Preventive Medicine Unit 5, San Diego, CA	Luke Air Force Base, AZ	
United States Army Medical Research Unit – Africa, Nairobi, Kenya	Navy Environmental and Preventive Medicine Unit 6, Pearl Harbor, HI	Tyndall Air Force Base, FL	
United States Army Research Unit – Georgia, Tblisi, GO	Navy Environmental and Preventive Medicine Unit 7, Rota, SP	Ramstein Air Force Base, Germany	
MEDCEN – Fort Bragg, NC	1st Medical Battalion, Camp Pendleton, CA	Misawa Air Base, Japan	
MEDCEN – Fort Hood, TX	2nd Medical Battalion, Camp Lejeune	Eielsen Air Force Base, AK	
	3rd Medical Battalion, Okinawa, JP	Seymour Johnson Air Force Base, NC	
MEDCEN – Fort Sam Houston, TX	Naval Medical Research Unit – 2, SINGAPORE		
MEDDAC – Fort Stewart, GA	Naval Medical Research Unit – 6, Lima, Peru		
Army Public Health Command, APG, MD	Naval Medical Research Unit – 3, Sigonella, Italy		

Public Health Activity-Korea, Camp Humphreys	Naval Medical Research Center, Silver Spring, MD		
Public Health Command – Atlantic, Fort Meade	Navy and Marine Corps Public Health Center USDA Gainesville Detachment, Gainesville, FL		
Public Health Command – Central, Fort Sam Houston, TX	Navy and Marine Corps Public Health Center CDC Detachment, Atlanta, GA		
Public Health Command – Europe, Landstuhl, Geramany	Uniformed Services University of Health Sciences, Bethesda, MD		
Public Health Command – Pacific, Fort Schafter, Hawaii	United States Air Force Academy, Colorado Springs, CO		
Public Health Command – Pacific, Camp Zama, Japan			
Public Health Command – Pacific, Fort Lewis, WA			
MEDCOM, Falls Church, VA			
AMEDD Center of Excellence, Fort Sam Houston, TX			
Medical Education and Training Center, Fort Sam Houston, TX			
United States Military Academy, West Point, NY			
Uniformed Services University of Health Sciences, Bethesda, MD			

5th Medical Detachment, Yongsan, Korea			
61st Medical Detachment, Fort Campbell, Kentucky			
71st Medical Detachment, Baumholder, Germany			
154th Medical Detachment, Daegu, Korea			
155th Medical Detachment, Fort Bragg, North Carolina			
172nd Medical Detachment, Fort Bragg, North Carolina			
233rd Medical Detachment, Fort Carson, Colorado			
224th Medical Detachment, Fort Hood, Texas			
227th Medical Detachment, Fort Lewis, Washington			
255th Medical Detachment, Fort Lewis, Washington			
485th Medical Detachment, Fort Polk, Louisiana			
926th Medical Detachment, Fort Benning, Georgia			
18th MEDCOM, HHC, Honolulu, HI			

* AF Medical Entomologists duty stations listed are those of the current officers (2 October 2020). Over 64 installations are available for duty assignements

Research Units

Army	Navy	Air Force
United States	**United States**	**United States**
Walter Reed Army Institute of Research, Silver Spring, MD	Naval Medical Research Center, Silver Spring, MD	Wright-Patterson Air Force Base, OH
Walter Reed Army Biosystematics Unit, Washington, DC	Navy and Marine Corps Public Health Center USDA Gainesville Detachment, Gainesville, FL	
United States Army Medical Research Institute of Infectious Diseases, FT Detrick, MD	Navy and Marine Corps Public Health Center CDC Detachment, Atlanta, GA	
Outside of the United States	**Outside of the United States**	
Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand	Naval Medical Research Unit – 2, Singapore	
United States Army Medical Research Unit – Africa, Nairobi, Kenya	Naval Medical Research Unit – 6, Lima, Peru	
United States Army Research Unit – Georgia, Tblisi, GO	Naval Medical Research Unit – 3, Sigonella, Italy	

100 Years of Entomology in the Department of Defense. Insect Potpourri: Adventures in Entomology. 1992. Harvey A. Shultz, CDR (ret.), MSC, USN

Introduction

On July 21, 1988, a group of 50 pest management professionals, most of them entomologists employed by the Department of Defense (DoD), purposefully filed into a conference room in Washington, DC. Commissioned officers and civilians alike, representing the Army, Navy and Air Force, and other federal agencies, they came to coordinate entomology, pest management and related functions at the 128th meeting of the Armed Forces Pest Management Board (AFPMB). The pace of the formal proceedings was intense, and the agenda ambitious. A dozen standing and ad hoc committees made recommendations regarding pesticides, dispersal equipment, training and certification of pest controllers, repellents, stored products, pest control research, and much more. Debate was spirited, but inevitably the voting members moved towards a consensus. Sitting in was Mr. William A. Parker, III, the Deputy Assistant Secretary of Defense for Environment to whom the Executive Director of the AFPMB reports. Mr. Parker used the occasion to praise the board for its field-oriented professionalism and environmental awareness. Appropriately, the meeting took place at Walter Reed Army Medical Center, named after the Army Medical Corps officer whose work on the transmission of yellow fever by mosquitoes almost a century ago marked the beginning of modern military entomology.

In 1889 there was no organized entomological resource available to military commanders. As each challenge presented itself, professionals, often physicians like Major Reed, were pressed into service. What is so special about entomology in today's military that demands the level of attention described above? Let's answer this question by tracing military entomology from its modest beginnings to present times.

The Early Days

One hundred years ago, the role of insects in disease transmission was poorly understood. Little had changed since the 1870's when the Surgeon General of the Navy quoted a prevailing theory of the day, "that yellow fever poison propagates itself rapidly and spreads by creeping along the ground…" Mosquitoes, flies, lice, ticks, and the like were regarded mostly as nuisances. Accordingly, there was no incentive for the military to engage the services of scientists knowledgeable in insect matters. In the 1880's and 1890's a few medical officers contributed observations, mostly concerning the enormity of mosquito swarms at Army camps and the primitive measures used to gain relief.

Then in 1898, a poorly prepared United States went to war with Spain. There were only 369 American battle casualties during the 118-day Spanish-American war. By contrast, 1,939 men died of disease, primarily typhoid fever contracted in volunteer camps in the United States. A Board of army Medical Officers including MAJ Walter Reed, concluded that the spread of the disease was due primarily to contact between soldiers and flies. (Thins might have been worse had the war lasted longer since the Surgeon General's share of the war budget was a meager $25,000!)

Surprising to some today, but not to military entomologists, these figures were predictable because casualties due to disease, primarily arthropod-borne disease, have exceeded battlefield casualties in every war fought by the United States!

Upon the conclusion of hostilities, MAJ William Crawford Gorgas, began the "sanitation" of Havana. However, an on-going outbreak of yellow fever continued unabated until 1901, when Walter Reed and Associates of the Yellow Fever Commission provided evidence that the *Aedes aegypti* mosquitoes could transmit yellow fever form man to man. Within-eight months, yellow fever was eradicated from Havana.

Gorgas put his Havana experiences to the test in Panama over the objections of some groups which did not agree with the mosquito transmission "theory." Fortunately, President Roosevelt had good entomological instincts and backed the Army Medical Department. The malaria rate was reduced was reduced from 1263/1000/annum (many individuals suffered multiple cases each year) in 1906 to 76/1000/annum in 1913. The United States might have failed to complete the Panama Canal, as did the French earlier, were it not for Gorgas' three part program – screening all dwellings, fumigating dwellings of victims, and eliminating or oiling standing water. By his own estimate over 70,000 livers were saved – primarily from yellow fever and malaria.

By the time WWI broke out, the link between microbial life, disease, and vectors was well established, but pieces of the puzzle were still missing. Malaria was not a serious problem among U.S. troops in Europe during the war, but almost 10,000 occurred in training camps in the southern U.S.A. In Macedonia, however, malaria-weakened British and German armies were unable to advance for three years.

WWI was fought largely in trenches, and as a consequence trench fever, a new disease known to be transmitted by body lice, was widespread. In response, the British Expeditionary Forces added two entomologists to each of their sanitary units. Delousing stations were established in Europe, and conditions were much improved by the time U.S. troops entered the conflict.

The British also cooperated with the U.S. Army Surgeon General in regard to experimental work on louse control and other vector problems. Poisonous gas, so deadly in the trenches of Europe, was tested for control of insects and diseases. Dry cleaning processes which controlled body lice on garments were perfected for the Quartermaster Corps. High frequency sound, not surprisingly, failed to do the same. More work was done in properly sizing mosquito meshes to exclude mosquitoes form cantonment buildings. For the first time a handful, no more than 8, entomologists were commissioned in the Army, while others served as non-commissioned officers assisting in the control of insects in Army camps.

The War Department called on the United States Department of Agriculture (USDA) Bureau of Entomology for assistance in controlling grain pests infesting immense warehouses in Brooklyn, NY and to protect forest resources needed to manufacture oars, handles, and airplanes – yes, airplanes.

References to military entomology in the literature between the world wars is sparse. However, an intriguing character, Clara Ludlow, performed mosquito taxonomy for the Army on a voluntary basis from 1901 till her death in 1924. Ms. Ludlow, the sickly daughter of a civil war medical officer, developed her interest while visiting her brother, an artillery officer stationed in the Philippine Islands. Her fascination with mosquitoes lead to a Ph.D., at age 55 and a final resting place in Arlington National Cemetery. Some consider her to have been the first "military entomologist," as among her publications are many clearly directed towards military problems.

WWII

For the past 45 years DoD has been the largest employer of medical entomologists in the world. But the military learned the importance of entomology the hard way – between the world wars only 14 Army entomologists were commissioned in the reserves! This is especially ironic, since during the same period knowledge of vector-borne disease grew impressively.

It seems predictable today that a little dappled-winged mosquito, the Anopheles, would cause five times more casualties among U.S.A. troops during WWII than would battlefield injuries! "Malaria discipline" had not been developed and the prevailing attitude, as expressed by a high ranking officer on Guadalcanal was, "We are out here to fight Japs and to hell with mosquitoes." The combination of effective vectors, susceptible troops, infected native and Japanese reservoirs, and prolific natural and battle-caused mosquito breeding sites set the stage for what was about to happen. Although only 1000 American lives were lost to arthropod-borne disease in WWII, the toll in lost manpower was staggering – almost 2 million cases totaling 24 million man-days lost!. In May of 1943, General MacArthur observed that, "This will be a long war, if for every division I have fighting the enemy, I must count on a second division in the hospital with malaria and a third division convalescing from this debilitating disease." Recognizing the impact of malaria on morale and fighting ability, a history of the U.S. Army medical department noted that, "The Pacific and Asiatic campaigns would have been impossible without control of malaria." Victory was possible because in 1940, the Army Surgeon General realized the U.S.A. could be drawn into a world conflict, and began to organize the Medical Department to meet any contingency. The new Preventive Medicine Service included a Malaria Control Branch and (under another Service) and Insect and Rodent Control Branch.

In 1941 the Naval Medical Department established the Hospital Volunteer Specialist Group and, the first two Navy entomologists (LTJG William K. Lawler and LT Paul Woke) were commissioned. BY the end of the WWII they had been joined by over 200 colleagues. In 1942, U.S. troops experienced a malaria rate on the Island of Efate, New Hebrides of 2600/1000/annum! A team including Ensign Kenneth L. Knight, the first entomologist to work in a combat zone, reduced the rate to essentially nil. Due to the devastating effect of malaria on U.S. troops in the Pacific in 1942, entomologists were recruited from USDA, the United States Public Health Service, and universities to staff survey and control teams. The South Pacific Malaria and Insect Control Organization was a joint Army-Navy-allied group. BY 1944 the War and Navy Departments had put 771 specially trained personnel in the field. Army entomologists

staffed 17 malaria survey detachments; still other units were involved in control. The Navy Division of Preventive Medicine established epidemiology units, which by 1944 numbered 122. Over 100 malaria control units led by entomologists and medical officers were distributed throughout Naval units and in forward areas. Navy entomologists also served in China, North Africa, the Caribbean, and Central Africa. William B. Herms, of the University of California, who had served as an officer in the Sanitary Corps of the Army in WWI, returned to duty for WWII to join 45 entomologists he helped train at Berkeley's Division of Entomology and Parasitology. Malaria cases overseas peaked in 1943 and then dropped dramatically. Due to the concurrent arrival of trained personnel and DDT, overall rates in the South Pacific dropped from 208/1000/annum in 1943 to 5/1000/annum for the first half of 1945. As a spin-off benefit, the entomological requirements of the day did wonders for the worldwide taxonomy of Anopheles, as keys were developed to aid in control efforts.

Malaria, however, was not the only arthropod-borne disease to adversely affect U.S. troops. During a 3-month period in 1944, 1000 of 3500 U.S. troops assigned to Saipan contracted "break-bone fever," or dengue. Scrub typhus, a debilitating disease transmitted by chigger mites, accounted to 18,000 casualties among allies troops in the Pacific-asiatic theater. There, mortality from scrub typhus was considerably higher than from malaria. In New Guinea elements of the 6th Infantry Division were rendered non-effective after suffering 931 cases an d 34 deaths within a few weeks of hitting the beach. Air Force personnel in Australia suffered an overall rate of 750/1000/annum. Control was accomplished by eliminating the coarse grass harboring wild rodents (the natural disease reservoir), and treating uniforms with a recently developed M-1960 clothing repellent.

Q fever, a rickettsial disease barely known at the time Pearl Harbor was attacked, may have accounted for 75% of the cases diagnosed as atypical pneumonia in northern Italy. This tick-borne disease decreased unit strength by as much as 30% and later caused great concern when 400 cases occurred in troops returning to Virginia.

Early in the war USDA was asked to coordinate disease prevention and vector control research projects. Of initial concern were the development of new repellents and pesticides to control scabies and the human body louse. The war stimulated a level of research in the control of arthropod-borne diseases unprecedented in history at the USDA lab in Orlando, Florida.

The history of technical developments in pest control resulting from wartime needs included the initial field use of synthetic organic pesticide (DDT) for vector control, the development of insecticide aerosols, the development of effective vector repellents and advances in fumigation.

The discovery in 1943 that DDT, applied as a residual spray on surfaces, was lethal to adult mosquitoes, led to a feasible plan for malaria eradication by interruption of the transmission cycle. (This strategy would later be validated by the World Health Organization in tis global eradication effort).

Later in the same year, louse-borne typhus broke out in allied-occupied Naples. Recalling the loss of life due to typhus at the end of WWI, the military dusted 2.5 million people in Italy (and later 2 million more along the Rhine River) with DDT. AS a result, no new cases of typhus were reported. Concerns as to environmental implications and other potential adverse effects would come later, but world-wide dependency on residual synthetic, organic pesticides had begun.

The need for a simple way to disperse insecticides in the field had become critical. Malaria cases exceeded battle casualties in the Sicilian campaign. At West African airbases the malaria case rate surpassed 2000/1000/annum. Less heralded that the development of the atomic bomb was a quest (marked by a similar urgency) for another bomb – the bug bomb. Two USDA researchers with support from the Army Medical Center, Walter Reed Hospital and the Aero-medical Laboratory, Wright Field, Dayton, Ohio produced the prototype, a 5 pound cylinder containing the newly available Freon 12, pyrethrin, and sesame oil. The aerosol was produced by inverting the cylinder and opening the valve. Within months American industry was able to improve the container and nozzle and deliver supplies to units in the field, a feat which must be considered amazing by contemporary standards. The aerosol insecticide bomb went on to launch a major postwar industry.

The Air Force's most noteworthy contribution to military entomology, appropriately, has been in aerial dispersal of insecticides. But the need for aerial spray preceded the separation of the Air Force from the Army. In cooperation with the USDA Orlando laboratory, the Army Air Force (AAF), in 1943, began developing apparatus for aerial dispersal of DDT to control adult and larval mosquitoes. The Fifth Air Force, equipped with L-4 aircraft, first used the new technique in New Guinea in 1944. The operation was directed by Captain W.C. McDuffie who later became chief of the USDA Laboratory for Insects Affecting Man and Animals. The original 32-gallon insecticide tanks, venture pumps and pipe-like dispersal systems, were soon replaced with 625 gallon tanks, hydraulic pumps and multi-nozzle booms mounted below the wings of B-25s and C-47s. Some Pacific beachheads were sprayed hours before top arrivals. In the Chine-Burma-India theater, the Philippines, and the Mariannas, volunteer aerial spray units were also formed; but for lack of entomological input, success varied.

The Army and Navy have also developed and deployed aerial spray systems with emphasis on supporting forward-deployed troops, in relatively small areas. IN 1943 two Navy entomologists "jury rigged" a French Amiot bomber in Morocco to disperse Paris green for malaria control. The following year, one of these officers, LT Joseph Yuill, adapted a system onto a Coast Guard HM5-4 in New York City, and insecticides were dispersed for the first time from a helicopter. The Army and Navy have continued to progress with helicopter-mounted aerial spray technology, while leaving large areas, fixed-wing applications to the Air Force.

In 1946 a special Aerial Spray Flight (SASF) was created at Greenville Army Air Base in South Carolina to continue research and to provide services to military installations in the United States. Today's Air Force aerial spray capability is part of the 356th Tactical Airlift Squadron at

Rickenbacker Air National Guard Base, Ohio. Large, but agile, C-130 aircraft are equipped with a modular spray system capable of high, low and ultra-low volume insecticide delivery.

After WWII few entomologists remained on duty, and most of the epidemiology units were disbanded. An exception was the Malaria and Mosquito Control Unit at Naval Air Station (NAS) Banana River, FL which was moved to NAS Jacksonville, FL in 1947 and eventually designated the Disease Vector Ecology and Control Center (DVECC). In 1959 a sister unit was established in Alameda, CA.

In 1949 DVECC Jacksonville began the development of insecticide dispersal equipment with the initial work on thermal aerosol (fog) applications. These dispersal units, which evolved from DVECC research, helped produce the cold foggers of the 1960s, the ultra low volume (ULV) units of the 1970s and in 1978 computer analysis of ULV droplets.

In 1951, this same unit was also the first to conduct training for civilian and military pest controllers. This type of training was made mandatory for commercial applicators by the Environmental Protection Agency (EPA) almost 25 years later. In the early 1970s the four week version of the training taught at both DVECCs and at the Army and Air Force schools was applauded by EPA as a model that the states might well follow.

Korea and Vietnam

Military entomologists also played a significant role during the Korean conflict, where arthropod-borne diseases again threatened military operations.

In 1950 modified C-40s, later L-5s on loan from the Army and finally T-6 aircraft were deployed to protect United Nations forces in Korea. The Korean spray unit, trained by SASF experts, used 20% DDT oil solution at 12 sites to control mosquitoes which were responsible for almost 1500 cases of malaria and Japanese B encephalitis in the first half of 1950. Later, as dysentery cases increased, Pusan, Taegu, and Seoul were sprayed to control flies.

On the ground, relapsing fever and typhus were also prevalent. One hundred percent of the internees at the Koje D Prisoner of War Camp became infested with DDT-resistant lice and innovative measures were required. Mass power delousing with newly approved insecticide lindane quickly reduced the infestation rate to 1%. In 1951 hundreds of admissions for epidemic hemorrhagic fever caused alarm. A rodent reservoir and arthropod vector were hypothesized and rates dropped immediately when uniforms were impregnated with M-1960 repellent.

Between 1962 and 1973 over 2 ½ million U.S. troops were exposed to arthropod-borne diseases in the Republic of Vietnam. At the height of the conflict, disease was responsible for over 70% of army hospital admissions, of which malaria and fevers of unknown origins accounted for half. Dengue, Japanese B encephalitis, scrub typhus, plague, and enteric diseases involving flies provided additional challenges for the dozens of military entomologists who served one-year tours in Vietnam. Units serving in the coastal plains (where malaria was not endemic and where large-scale malathion applications by Air Force c-123's helped control

anopheline mosquitoes) did not experience high malaria rates. Weekly cholorquine-primaquine tablets (and in the case of Army troops, daily dapsone pills) prevented malaria when discipline was strictly enforced. Nevertheless, from 1966 through 1970 the Army alone recorded over 38,000 cases of malaria and 60 deaths. Most victims were from combat units operating in the hyperendemic Central Highlands where the parasite Plasmodium falciparum and a large local parasite reservoir were present. At the height of the conflict, rates among Army troops averaged between 30-90/1000/annum, but much higher rates occurred among units in the field. IN response, the Army deployed the 20th Preventive Medicine Unit in Bien Hoa and the 172nd Preventive Medicine Unit in An Khe. Each provided detachments staffed with an entomologist in direct geographic support of local units. Entomologists helped enforce malaria discipline by providing commanders a field colometric test to detect chloroquine in the urine. Soldiers who had not been taking ant-malaria pills were disciplined, and malaria rates were sharply reduced in combat units. Entomologists also coordinated field collection of vectors needed both for medical research and for scheduling control efforts. Helicopter-mounted spray rigs were used at times to reduce malaria in forward areas such as fire bases and landing zones, but aerial spray could not be provided where it was needed most due to vulnerability to enemy fire. As the conflict progressed it became increasingly clear that there were was no effective method for vector control in combat areas. So entomologists taught personal protective methods to two-man field sanitation teams (one team assigned per company) emphasizing proper wearing of the uniform, use of bed nets, and use of DEET repellent. The Navy's Preventive Medicine Unit in Danang similarly distinguished itself supporting Marine Corps and Seabee Units in the northern provinces.

Another significant entomological challenge was plague. Although several hundred civilian cases occurred in the 1960's, many in immediate proximity to U.S. bases, only a dozen Americans were infected. Large scale dusting of villages and burrows to control rodent fleas, and a relatively new vaccine figured in this success story. Of great concern during the later stages of the conflict was prevention of plague importation into the United States in retrograde cargo. One of the largest U.S. transportation complexes in Vietnam, Cam Ranh Bay, completely surrounded by a plague-infested village. Entomologists there coordinated the treatment of U.S.-bound transportable shipping containers with paraffinized rodenticide bait blocks and insecticides.

The lessons learned in Vietnam helped spark renewed peacetime emphasis on preparedness by entomologists to provide immediate comprehensive support of rapidly deploying troops anywhere in the world.

Military Entomology Today

Historically, military entomology has only been evident during actual campaigns and a product of our need to protect troops from vector-borne disease. This resulted in the practice of medical entomology only, a concept which had gradually changed. Following the end of World War II, it soon became evident that a continuing effort in protection of the health of personnel, subsistence items in storage, and structures was essential. Military personnel were being

retained in countries where insect-borne diseases were prevalent. The support and maintenance of these forces required the procurement and storage of large quantities of food, clothing, and other materials subject to insect attack.

DoD's total assets are vast. In round numbers, three million uniformed and civilian personnel work at over 1200 installations, some (250) being equal to a medium-sized city. Stewardship is provided to a multi-billion dollar investment in insect-susceptible personnel, buildings and materiel. Through the foresight of a few entomologists who had remained with the armed forces after WWII, programs were developed to prevent or control pest problems. Today, DoD has a balanced program encompassing both the medical and economic aspects of the field.

By the mid 1950s, the Services realized that pest management requirements at installations in the US required a new level of attention. Since pest control could conveniently be aligned with other maintenance support functions, civilian entomologists were hired by the responsible agencies and "engineering entomology" in DoD was born. Entomologists George L. Hutton, Navy Bureau of Yards and Docks, Doyle H. Reed, Office of the Army Chief of Engineers and Rufus H. Vincent, Air Force Director of Installations helped pioneer this concept.

The Army now employees 52 civilian entomologists, the Navy 21 and the Air Force 8, many of whom provide command-wide or geographical integrated pest management support. They implement programs which insure that insects and other living things do not interfere with operations, destroy property or materiel, or adversely affect human health. These pest management professionals develop long range, comprehensive, environmentally compatible, economical pest management plans for supported installations. Plans are updated and reviewed periodically on-site for compliance. OF special interest is the safe selection, storage, formulation, application, and disposal of pesticides, though non-chemical means of control are preferred wherever feasible. Civilian entomologists also participate in training pest controllers and pest control contract inspectors. Entomologists write and/or tailor contract specifications for pest control work to help insure receipt of quality pest control services. Where in-house work prevails the wooden pest control shops of the 1950s have been replaced with well engineered, state of the art facilities designed to protect workers and the environment from the adverse effects of pesticides. Mission-oriented engineer entomologists, by virtue of their responsibilities often become "generalists." They grow professionally on the job to develop expertise in such diverse fields as animal damage control (in some cases even including bird/aircraft strike hazard reduction), weed control, and wood protection.

The entomology program in the Services today is characterized by the readiness and quality of its professional personnel. Most DoD civilian entomologists hold advanced degrees and are affiliated with the American Registry of Professional Entomologists (ARPE). Active duty entomologists today number 72 in the Army, 39 in the Navy, and 16 in the Air Force, while many more entomologists serve in the Reserve and National Guard. The masters degree is prerequisite for commissioning and most officers hold PhDs. ARPE registration is the norm. Senior officers fill tops level environmental and medical staff positions, but none forget that they

are field troops first. Among the 241 killed when the Marine barracks in Beirut, Lebanon was bombed in 1983, was the only assigned physician and most of the corpsmen. One of the officers who stepped forth to oversee the emergency patient triage, treatment, and evacuation was a Navy entomologist.

Although DoD's primary entomological role is to support military operations the 1950 enactment of the Catastrophe Aid Bill meant resources could be used to assist in the control of civilian epidemics. Navy Vector Control Teams provided assistance after the Great Kansas City Flood (1951); fly control during polio epidemics in South Florida; and mosquito control during St. Louis Encephalitis outbreaks. A combined service effort was used during the 1971 Venezuelan Equine Encephalitis outbreaks, when U.S. Army entomologists provided surveillance of mosquito populations and the U.S. Air Force Spray flight conducted aerial spray missions. Outbreaks of economic pests, primarily locusts and grasshoppers, have been aerially sprayed both stateside and overseas. Many other mission, too numerous to elaborate here, have been conducted to suppress both disease vectors and economic pests.

All of which brings us back to the opening scenario in the article and to the Armed Force Pest Management Board. In recognition of the developing international role of the armed forces, the Board was established in 1957 to develop and coordinate an interagency approach to controlling insects and related pests of medical and economic importance. A dozen Army, Navy, and Air Force Commands were appointed to the original Board with 9 liaison members from U.S.A., Canadian, and British agencies. Since then, there has been a name change, re-designation of titles and duties of key personnel, reassignment with DoD, and expansion of the mission. Today's Board develops and recommends DoD policy, provides technical and scientific advice to DoD Components, coordinates DoD pest management activities, works with a Pesticide Hot Line (operated by the US Army Environmental Hygiene Agency), sponsors the Defense Pest Management Information Analysis Center (DPMIAC), and provides liaison officers to coordinate entomology research and contingency efforts worldwide. This unique organization is composed of medical and engineering pest management professionals from each of the military departments and over 40 military agency representatives. Approximately 35 other federal organizations and allied defense agencies are represented by liaison members.

Information is the lifeblood of today's computerized DoD entomologist. To this end the DPMIAC maintains a library and automated bibliographic database, and also accesses the major technical information resources. The Center provides each DoD entomologist with a comprehensive Technical Information Bulletin. The DPMIAC has developed a Global Pesticide Resistance Inventory and a series of Disease Vector Profiles which describe the arthropod-borne diseases and vector present in most countries of the world.

The military has vigorously pursued entomological research and development in the areas of vector biology/ecology/control, epidemiology or arthropod-borne disease, resistance, methods of protecting individuals and groups from arthropod-borne disease, improved insecticides/repellents and improved equipment/techniques for the dispersal of these chemicals. The Army has research operations at the Biomedical Research and Development Laboratory and the Medical Research

Institute for Infectious Diseases, both located at Fort Detrick, MD and Walter Reed Army Institute of Research, Washington, DC in the US, as well as overseas sites, including Thailand, Malaysia, Brazil, and Kenya. One of the most recent and notable Army R&D efforts has been the development of a longer lasting DEET repellent lotion, and a new repellent treatment for uniforms. The Navy stations research entomologists in locations abroad including Peru, Egypt and Indonesia. But the needs are greater than in-house resources can fulfill, so the excellent relationship begun with the USDA Orlando Laboratory during WWII has been perpetuated and expanded. Today several USDA labs provide support for DoD research needs regarding disease vectors, stored products pests and wood-attacking insects. Universities and civilian contractors satisfy still other research needs. Over the years, DoD entomological research has seen considerable success in developing materials and strategies to protect operational forces from endemic vector-borne diseases.

A Look Ahead

Looking into the future, we will find that the mission of military entomology will remain: Conserve the Fighting Strength. To this end, our efforts will focus on the need to protect susceptible troops, who must deploy anywhere in the world on an instant's notice, from arthropod-borne disease. However, we cannot lose sight of the fact that we must also maintain the facilities and other resources we use to train and outfit these troops. One of the greatest challenges to our entomologists will be to accomplish this task in a period of heightened environmental concern, stricter tightening pesticide regulations and tightening budgets. To meet this challenge innovative IPM strategies, some being developed today and other perhaps not yet imagined, will be needed.

Annual Meeting of the Entomological Society of America, Proceedings of the DoD Symposium, "Evolution of Military Medical Entomology."
https://apps.dtic.mil/dtic/tr/fulltext/u2/a506261.pdf

"For the past several years, the Armed Forces Pest Management Board (AFPMB) has organized a symposium on some aspect of military entomology at the annual meeting of the Entomological Society of America. The 2008 meeting was held in Reno, Nevada and our symposium was held on the 16th of November. The theme of the symposium was "Evolution of Military Entomology". Our idea was to show how the discipline of military medical entomology, along with some aspects of public health evolved." CAPT Stan Cope, MSC, USN, Director, Armed Forces Pest Management Board

Entomologists in World War II, Eugene J. Gerberg, COL, Medical Service Corps, U.S. Army (Retired): https://apps.dtic.mil/dtic/tr/fulltext/u2/p023969.pdf

"After World War I, the War Department provided for the commissioning of entomologists in the Army Organized Reserve as Sanitary Corps Officers. In 1940, the Army Surgeon General realized that the U.S. could be drawn into a world conflict and began to organize the Medical Department to support this effort. It was recognized that the prevention and control of malaria in posts in the Southern states and in the possible overseas areas was one of the principal problems facing the military buildup. In considering the control of malaria ion the Southern states, it was recognized that an extensive mosquito control program would have to be implemented. The fourteen entomologists in the Organized Reserves were ordered to Active Duty in 1941 and assigned to military installations in the South, where malaria was a potential hazard to service members……." – Eugene Gerberg, COL(ret), MSC, USA

U.S. Army Entomology Support to Deployed Forces, Stephen B. Berté :https://academic.oup.com/ae/article-pdf/51/4/208/18744486/ae51-0208.pdf

"Military history is filled with accounts of the devastating effects that arthropod-borne disease can have on military campaigns. Although many people believe the primary cause of death and hospitalization of soldiers in a conflict is the result of hostile action, disease and non-battle injuries account for the greatest loss of personnel from military units engaged with an enemy, and much of the disease is transmitted by arthropods. Improvements in field sanitation techniques have decreased illness among deployed forces resulting from improper handling of food, water, and human waste. Arthropod-borne disease, however, is still a very real threat to our army. To deal with this threat, the U.S. Army has a corps of medical entomology officers on its preventive medicine team who deploy with the army. Operation Enduring Freedom (OEF) in Afghanistan and Operation Iraqi Freedom (OIF) are no exception. In this article, I give a brief summary of some of the activities in which army medical entomologists are involved as they support deployed U.S. Forces; and I focus on operations in Southwest Asia." Stephen Berté, COL(ret.), MSC, USA

The role of the United States military in the development of vector control products, including insect repellents, insecticides, and bed nets. 2009. Lynn W. Kitchen, Kendra L. Lawrence Russell E. Coleman: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1948-7134.2009.00007.x

"Arthropod-borne diseases such as malaria, dengue, scrub typhus, and leishmaniasis continue to pose a significant threat to U.S. military forces deployed in support of operational and humanitarian missions. These diseases are transmitted by a variety of arthropods, including mosquitoes, ticks, chiggers, sand flies, and biting midges. In addition to disease threats, biting arthropods can cause dermatitis, allergic reactions, and sleep loss; therefore, monitoring of vector impact and integrated use of personal protective measures (PPM) and methods to reduce the vector populations are needed to protect service members. The U.S. military has played a vital role in vector identification tools and the development and testing of many of the most effective PPM and vector control products available today, including the topical repellent DEET and the repellent/insecticide permethrin, which is applied to clothing and bed nets. Efforts to develop superior products are ongoing. Although the U.S. military often needs vector control products with rather specific properties (e.g., undetectable, long-lasting in multiple climates) in order to protect its service members, many Department of Defense vector control products have had global impacts on endemic disease control."

Insect Problems in World War II with Special References to the Insecticide DDT
F. C. Bishopp: https://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.35.4.373

"Insects and the diseases they carry have played a dominant role in determining the outcome of major military operations throughout recorded history. There appears to be little doubt that Napoleon's campaign against Russia failed because of outbreaks of louse-borne typhus and that his operations in the New World aborted because of yellow fever and malaria. The fall of the Roman Empire has been attributed by many writers to the occurrence of epidemic diseases both among the armies and among the civil populations. The lack of knowledge of the nature of the diseases involved, their means of transmission, and effective methods' of control would make it impossible for an organization of the magnitude of the Roman Empire to continue its existence on such a scale. The statement that among our troops in the Spanish-American War insect transmitted diseases took more lives than Spanish bullets is well founded, as is also the statement that the long stalemate existing between the German and British troops in the Gallipoli campaign in World War I was due to the large number of men in each army who were incapacitated by malaria." F. C. Bishopp

Malaria in American Troops in the South and Southwest Pacific in World War II. Robert J. T. Joy: https://pdfs.semanticscholar.org/3014/cf0b0fff6400130dcaf4712c4d8c414fa99e.pdf

"This paper discusses the operational and medical aspects of malaria in American forces. The lessons apply equally to the Australian army; their story is splendidly told elsewhere.1 Of necessity, the tactical and operational background must be sketched in. Those soldiers and marines were not in the jungles by choice; it was a war that put them there, it was a war that exposed them to malaria, and it was a war that forced the application of peacetime knowledge, and wartime research that eventually solved the military medical problem."

History of Navy Entomology, 1941-2011: http://online.fliphtml5.com/koxj/vpvd/#p=1

"The field of military medical entomology originated in 1900 with Major Walter Reed's work examining transmission of the Yellow Fever virus to humans by the mosquito *Aedes aegypti*. Just 40 year later, fighting in the Pacific Theater during World War II would clearly demonstrate the importance of military entomology to the success of the U.S military and mark the beginning of Navy Entomology."

Medical Entomology in the United States Department of Defense: Challenging and Rewarding. Stanton Cope, George Schoeler, Gregory Beavers.
https://apps.dtic.mil/dtic/tr/fulltext/u2/a549798.pdf

"It may surprise you to learn that the United States Department of Defense (DoD) maintains a highly-trained cadre of about 115 active duty uniformed entomologists. Approximate numbers across the services are Army-65, Navy-35 and Air Force-15. Although the primary focus is on medical entomology and pest management, DoD entomologists are involved in a wide variety of interesting and at times unique activities, many of which will be highlighted in this article."

Pest Management Guidance

Federal:

Environmental Protection Agency

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): https://www.epa.gov/laws-regulations/summary-federal-insecticide-fungicide-and-rodenticide-act

Department of Defense

Washington Headquarters Services-Executive Services Directorate – location of Department of Defense issuances to include instructions, directives and manuals (https://www.esd.whs.mil/dd/dod-issuances/)

DoD Instruction 4150.07, "DoD Pest Management Program"
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/415007p.pdf?ver=2019-12-26-104614-100

DoD Manual 4150.07 (Volume 1): "DoD Pest Management Program Elements and Implementation: Structure and Operation"
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415007_vol1.pdf?ver=2020-01-22-132922-467

DoD Manual 4150.07 (Volume 2): "DoD Pest Management Program Elements and Implementation: Pesticide Applicator Training and Certification Program"
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415007_vol2.PDF?ver=2020-01-22-132922-573

DoD Directive 4715.1E, "Environment, Safety, and Occupational Health (ESOH)"
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/47151Ep.PDF?ver=2019-12-30-141505-590

DoD Directive 5134.01, "Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L))
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/513401p.pdf?ver=2019-01-14-105114-333

DoD Instruction 3000.12, "Management of U.S. Global Defense Posture (GDP)"
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/300012p.pdf?ver=2019-01-29-103244-247

DoD Instruction 4715.03, "Natural Resources Conservation Program"
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/471503p.pdf?ver=2019-02-28-120916-070

DoD Instruction 4715.05, “Environmental Compliance at Installations Outside the United States” https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/471505p.pdf?ver=2019-02-28-120912-227

DoD Instruction 4715.22, “Environmental Management Policy for Contingency Locations” https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/471522p.pdf?ver=2019-03-07-133843-183

DoD Instruction 6055.05, “Occupational and Environmental Health (OEH)” https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/605505p.pdf?ver=2019-04-04-095234-197

DoD Instruction 6490.03, “Deployment Health” https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/649003p.pdf?ver=2019-06-19-134540-850

DoD Directive 3000.10, “Contingency Basing Outside the United States” https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/300010p.pdf?ver=2018-10-03-074326-980

DoD Directive 6420.02, “DoD Biosurveillance” https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/642002p.pdf?ver=2020-09-17-151634-613

Executive Order 11850 – Renunciation of certain uses in war of chemical herbicides and riot control agents. https://www.archives.gov/federal-register/codification/executive-order/11850.html

Executive Order 13751 – Safeguarding the Nation from the Impacts of Invasive Species. https://www.federalregister.gov/documents/2016/12/08/2016-29519/safeguarding-the-nation-from-the-impacts-of-invasive-species

Defense Transportation Regulation 4500.9-R-Part V, “Customs” https://www.ustranscom.mil/dtr/dtrp5.cfm

Foreign Clearance Guide https://www.fcg.pentagon.mil/fcg.cfm

DoD Pest Management Program Policy Questions

What issuances describe the DoD pest management program?

Identify and describe the organizational relationships within the DoD and Component pest management programs.

What are the responsibilities of the Assistant Secretary of Defense for Sustainment (ASD(S)) with regard to the Department of Defense pest management program? Where is that information found?

What are the responsibilities/roles of the Armed Forces Pest Management Board (AFPMB)? Where is that information found?

DoDI 6055.05 and 6490.03 require Component heads to do what concerning occupational exposures to pesticide hazards?

Component heads must program, plan and budget pest management programs to…….

What is the purpose of Executive Order 11850?

What are the responsibilities of the Integrated Pest Management Consultant (IPMC)? What training is required? How often? Where is that information found?

What are the installation pest management responsibilities of Army, Navy and Air Force Public Health or Preventive Medicine Personnel? Where is that information found?

What information is required to be included in an installation pest management plan?

How often are installation pest management programs required to be reviewed on-site? Who conducts that review?

What are the responsibilities of a Pest Management Consultant?

Pest management professionals must be currently certified in the appropriate pesticide applicator categories if they do what?

Contractor employees performing pest management work on a DoD installation within the United States must possess what type of certification? Who is responsible for ensuring this requirement is met?

What type of pesticide applicator certification must contractors who apply pesticides on DoD installations outside of the United States hold?

What are the pesticide applicator certification requirements for contractors who apply pesticides in contingency locations?

Who evaluates pest management contractor performance? Are there specific training requirements and if so, what are they?

Must individuals that apply non-restricted use pesticides from installation self-help programs be DoD pesticide applicator certified?

Can non-EPA registered pesticides be used in contingency locations? If so, what are the requirements?

When can non-AFPMB approved pesticides be used during DoD pest management operations?

Who coordinates pesticide disposal on an installation? Where can the guidelines be found?

What pest management practices are prohibited in the DoD?

What is a NPDES permit? When is it needed?

What is DoD policy WRT pesticide application in the range of threatened and endangered species?

Name situations where pest management and natural resources should coordinate activities.

Describe DoD pest management program records and reporting requirements.

When is pesticide applicator certification not required when applying pesticides?

Describe circumstances that require aircraft disinsection.

Who can validate/approve an aerial pesticide application project?

What is the responsibility of DoD in managing invasive species? What is the role of the DoD pest management program?

Military personnel supporting contingency operations or deployments are exempt from pesticide applicator certification under what conditions?

What is required to apply pesticides in the range of threatened and endangered species?

Identify and describe DoD prohibited pest management practices.

What are the 5 DoD pest management training programs?

Describe the pest management training requirements for reserve component, national guard and Coast Guard pest management personnel.

What is the purpose of pesticide applicator correspondence training?

What is the purpose of apprentice training?

What is a pest management professional (PMP)? What are the pesticide applicator certification requirements for a PMP?

When is pesticide applicator certification not required to apply pesticides in the DoD?

Describe pesticide applicator re-certification requirements.

Department of the Army
ATP 4-02, Force Health Protection.
https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/atp4_02x8.pdf

DA PAM 40-11, Preventive Medicine.
https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/p40_11.pdf

Department of the Navy
OPNAVINST 6250.4C, Navy Pest Management Program.
https://www.secnav.navy.mil/doni/Directives/06000%20Medical%20and%20Dental%20Services/06-200%20Preventive%20Medicine%20Services/6250.4C.pdf

Department of the Air Force
Air Force Instruction 48-105, Surveillance, Prevention and Control of Diseases and Conditions of Public Health Significance. https://www.acq.osd.mil/eie/afpmb/docs/issuances/afi48-105.pdf

Air Force Manual 32-1053, Integrated Pest Management. https://static.e-publishing.af.mil/production/1/af_a4/publication/afman32-1053/afman32-1053.pdf

Installation Pest Management Resources

DoD Manual 4150.07 (Volume 1): "DoD Pest Management Program Elements and Implementation: Structure and Operation" https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415007_vol1.pdf?ver=2020-01-22-132922-467

Armed Forces Pest Management Board Technical Guide 2 – Integrated Pest Management in Child Development Centers and Schools (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg2.pdf)

Armed Forces Pest Management Board Technical Guide 5 – Integrated Pest Management for Food Service Managers (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg5.pdf)

Armed Forces Pest Management Board Technical Guide 7 – Installation Pesticide Safety (https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg7.pdf)

Armed Forces Pest Management Board Technical Guide 17 – Military Handbook, Design of Pest Management Facilities (https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg17.pdf)

Armed Forces Pest Management Board Technical Guide 18 – Installation Integrated Pest Management Program Guide (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg18.pdf)

Armed Forces Pest Management Board Technical Guide 29 – Integrated Pest Management in and Around Buildings (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf)

Armed Forces Pest Management Board Technical Guide 39 – Preparing DoD Pest Control Contract and Assessing Contract Performance (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg39.pdf)

Federal Acquisition Institute COR Toolkit (https://www.fai.gov/resources/COR-toolkit?utm_medium=email&utm_source=govdelivery)

Pest Identification Resources

A Rapid Identification Guide for Larvae of the Most Common North American Container-Inhabiting *Aedes* Species of Medical Importance (http://www.mvcac.org/amg/wp-content/uploads/Rapid-ID-of-container-mosquito-larvae-in-USA-JAMCA-20131.pdf)
Walter Reed Biosystematics Unit (https://wrbu.si.edu/)

Arthropod Anatomy, R.E. Snodgrass (https://d3p9z3cj392tgc.cloudfront.net/wp-content/uploads/2019/03/27164152/9781501740794.pdf)

Centers for Disease Control - Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance – Ticks
(https://www.cdc.gov/nceh/ehs/docs/pictorial_keys/Ticks.pdf)

Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico (http://mosquito-taxonomic-inventory.info/sites/mosquito-taxonomic-inventory.info/files/Darsie%20%26%20Ward%201981.pdf)

Interactive Identification Key for the Hard Ticks (Ixodidae) of the Eastern
(https://digitalcommons.georgiasouthern.edu/usntc_key/)

Interactive Program for Teaching Adult Mosquito Morphology
(https://www.acq.osd.mil/eie/afpmb/docs/interactivecds/AdultMosquitoDVD.iso)

Interactive Program for Teaching Tick Morphology
(https://www.acq.osd.mil/eie/afpmb/docs/interactivecds/TickCD.iso)

Interactive Program for Teaching Larval Mosquito Morphology
(https://www.acq.osd.mil/eie/afpmb/docs/interactivecds/LarvalMosquitoDVD.iso)

Military Tick Identification/Infection Confirmation Kit
(https://phc.amedd.army.mil/PHC%20Resource%20Library/TG384_MILTICK.pdf)

Morphology and Insects (https://faculty.ucr.edu/~legneref/biotact/bc-51b.htm)

Mosquito Genera Identification Key Africa Command Area of Responsibility and Egypt
(https://phc.amedd.army.mil/PHC%20Resource%20Library/TG369_AFRICOMMosquitoKey.pdf)

Mosquito Genera Identification Key Southern Command Area of Responsibility (https://usaphc.amedd.army.mil/PHC%20Resource%20Library/TG370_SOUTHCOMMosquitoKey.pdf)

Mosquito Genera Identification Key for the United States and Alaska (https://phc.amedd.army.mil/PHC%20Resource%20Library/TG371_USandAlaskaMosquitoGeneraKey.pdf)

Mosquito Taxonomic Inventory (http://mosquito-taxonomic-inventory.info/)

Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with Dengue Virus Transmission (https://www.researchgate.net/publication/228820694_Pictorial_keys_for_the_identification_of_mosquitoes_Diptera_Culicidae_associated_with_Dengue_Virus_Transmission)

The Diversity of Hornets in the Genus Vespa (Hymenoptera: Vespidae; Vespinae), Their Importance and Interceptions in the United States (https://academic.oup.com/isd/article/4/3/2/5834678)

VectorMap Mosquito Identification Keys, Walter Reed Biosystematics Unit (http://vectormap.si.edu/Mosquito_Keys.htm)

Medically Important Pests

Tick Resources

Identification/Bionomics

Centers for Disease Control – Guide to the Surveillance of Metastriate Ticks (Acari: Ixodidae) and their Pathogens in the United States (https://www.cdc.gov/ticks/pdfs/Tick_surveillance-P.pdf)

Centers for Disease Control - Laboratory Identification of Arthropod Ectoparasites (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3910909/pdf/zcm48.pdf)

Centers for Disease Control - Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance – Ticks (https://www.cdc.gov/nceh/ehs/docs/pictorial_keys/Ticks.pdf)

Centers for Disease Control - Tick-borne Diseases of the United States: (https://www.cdc.gov/ticks/tickbornediseases/index.html)

Georgia Southern University Interactive Identification Key for the Hard Tick (Ixodidae) of the Eastern US (http://us-tick-key.klacto.net/)

Northeast Regional Center for Excellence in Vector-borne Disease: https://www.neregionalvectorcenter.com/ticks

Rutgers University, A pictorial key to differentiate the recently detected exotic *Haemaphysalis longicornis* Neumann, 1901 (Acari, Ixodidae) from native congeners in North America (https://zookeys.pensoft.net/article/30448/)

The TickApp for Texas and the Southern Region (https://tickapp.tamu.edu/identification.html)

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 26: Tick-borne Diseases: Vector Surveillance and Control (https://extranet.acq.osd.mil/eie/afpmb/cac/ticks/tick_reference/Tick-Borne%20Diseases-%20Vector%20Surveillance%20and%20Control%20AFPMB%20TG%20No.%2026.pdf)

Connecticut Agricultural Experiment Station - Tick Management Handbook (https://extranet.acq.osd.mil/eie/afpmb/cac/ticks/tick_reference/Tick%20Management%20Handbook.pdf)

Environmental Protection Agency - Federal Initiative: Tick-borne Disease Integrated Pest Management White Paper: https://www.epa.gov/sites/production/files/2016-02/documents/tick-ipm-whitepaper.pdf

Integrated Pest Management in Controlling Ticks and Tick-Associated Diseases (https://extranet.acq.osd.mil/eie/afpmb/cac/ticks/tick_reference/Integrated%20Pest%20Management%20in%20Controlling%20Ticks%20and%20Tick-Associated%20Diseases.pdf)

Northeast Regional Center for Excellence in Vector-borne Diseases - Tick Surveillance Practices in the Northeast (https://ecommons.cornell.edu/handle/1813/69534)

Review: Application of Tick Control Technologies for Blacklegged, Lone Star, and American Dog Ticks (https://academic.oup.com/jipm/article/9/1/12/4967809)

Mosquito Resources

Identification/Bionomics

Army Public Health Center – Mosquito Genera Identification Key/United States and Alaska (https://phc.amedd.army.mil/PHC%20Resource%20Library/TG371_USandAlaskaMosquitoGeneraKey.pdf)

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance – Mosquitoes (https://www.cdc.gov/nceh/ehs/docs/pictorial_keys/Mosquitoes.pdf)

Walter Reed Biosystematics Unit (http://www.wrbu.org/)

World Health Organization -Vector Bionomics in the Epidemiology and Control of Malaria (http://whqlibdoc.who.int/hq/1984/VBC_84.6_eng.pdf?ua=1)

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 47 - *Aedes* Mosquito Vector Control (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg47.pdf)

Armed Forces Pest Management Board Technical Guide 48 - Contingency Pest and Vector Surveillance (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg48.pdf)

Centers for Disease Control
West Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control (https://www.cdc.gov/westnile/resources/pdfs/wnvGuidelines.pdf)

Filth Fly Resources

Identification/Bionomics

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance – Flies (https://www.cdc.gov/nceh/ehs/docs/pictorial_keys/Flies.pdf)
PestWeb Filth Flies (https://pestweb.com/pests/category/a34f8/filth-flies**)**

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 30 – Filth Flies: Significance and Control in Contingency Operations
(https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg30.pdf)

New Mexico Department of Health – Filth Flies of Public Health Importance
(https://nmhealth.org/publication/view/guide/995/)

World Health Organization – Houseflies
(https://www.who.int/water_sanitation_health/resources/vector302to323.pdf)

Sand Fly Resources

Identification/Bionomics

Walter Reed Biosystematics Unit – Sand Fly Identification Resources
(http://www.wrbu.org/index.html)

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 49: Sand flies surveillance and control in contingency operations (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg49.pdf)

Biting Flies (Other than mosquitoes and sand flies) Resources

Identification/Bionomics

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 48 – Contingency Pest and Vector Surveillance (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg48.pdf)

Reduviidae (*Triatoma* spp) Resources

Identification/Bionomics
Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance – Bugs (https://www.cdc.gov/nceh/ehs/docs/pictorial_keys/Bugs.pdf)

Surveillance/Management
Centers for Disease Control – Chagas Disease (https://www.cdc.gov/parasites/chagas/gen_info/vectors/index.html)

Lice (*Pediculus corporis*) Resources

Identification/Bionomics
Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Surveillance/Management
Army Public Health Center – Louse-borne typhus (https://phc.amedd.army.mil/PHC%20Resource%20Library/Louse-BorneTyphus_FS_18-070-0317.pdf
Armed Forces Pest Management Board Technical Guide 6 – Delousing Procedures for Contingency Operations (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg6.pdf)
Centers for Disease Control – Body Lice (https://www.cdc.gov/parasites/lice/body/index.html)

Fleas (*Xenopsylla cheopis*) resources

Identification/Bionomics
Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Surveillance/Management
International Journal of Infectious Diseases (https://reader.elsevier.com/reader/sd/pii/S1201971210000299?token=4825508C0D5E1F31C4C1C322960B4BD5F2AE0E9C442F647DF155150738F4553D9246AABE9079F1F9061D62B27F3E1792)

Mites (Trombiculids)

Identification/Bionomics

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 29 – Integrated Pest Management in and Around Buildings (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf)

Living Hazards

Armed Forces Pest Management Board – Quick Cross Reference File (Developed by 1LT(P) Paula Mischler)(https://www.acq.osd.mil/eie/afpmb/docs/lhd/quick_cross_reference.xlsx)

Armed Forces Pest Management Board – Database (search by scientific name)(https://www.acq.osd.mil/eie/afpmb/docs/lhd/venomous_animals_byspecies.pdf)

Armed Forces Pest Management board – Database (search by country)(https://www.acq.osd.mil/eie/afpmb/docs/lhd/venomous_animals_bycountry.pdf)

DoD Partners in Amphibian and Reptile Conservation (https://www.denix.osd.mil/dodparc/parc-resources/)

2019 Ranked List of Infectious Disease Threats to the DoD (Global)

Rank	Disease
1	Diarrhea, bacterial
2	Influenza
3	Dengue
4	Malaria
5	Multi-drug Resistant Organisms
6	Diarrhea, viral
7	Crimean-Congo hemorrhagic fever
8	Leptospirosis
9	Acute respiratory, viral
10	Chikungunya
11	Rickettsiosis (SFG)
12	Hantavirus
13	Severe fever thrombocytopenia syndrome (SFTS)
14	Lassa and other arenavirus hemorrhagic fevers
15	Hepatitis E
16	Rift Valley fever virus
17	Rabies
18	Zika
19	Tick-borne encephalitis
20	Typhoid/paratyphoid fever
21	Schistosomiasis
22	Meningococcal meningitis
23	Leishmaniasis
24	Brucellosis
25	Q fever
26	Anthrax
27	MERS-CoV
28	Japanese encephalitis
29	Ebola
30	Diarrhea, protozoal
31	HIV/AIDS
32	Soil-transmitted helminths (hookworm, strongyloidiasis, cutaneous larva migrans)
33	Sandfly fever virus
34	Lyme
35	West Nile virus
36	Plague
37	Invasive fungal wound infection
38	Tuberculosis
39	Melioidosis

40	Typhus, mite-borne scrub typhus
41	St Louis encephalitis
42	Trypanosomiasis, Gambiense (Africa)
43	Bartonellosis (Oroya fever)
44	Equine encephalitis (EEE/WEE)
45	O'nyong-nyong
46	Marburg
47	Hepatitis B
48	Nipah virus
49	Typhus, murine (flea-borne)
50	Typanosomiasis, American (Chagas disease)
52	Mayaro
52	Ross River virus
53	Hepatitis A
54	Yellow fever
55	Tularemia
56	Venezuelan equine encephalitis
57	Sindbis virus
58	Oropouche
59	California serogroup viruses
60	Trypanosomiasis, Rhodesiense (African)
61	Barmah Forest virus
62	Murray Valley encephalitis
63	Alkhurma
64	Kyasanur Forest disease
65	Omsk

Infectious Diseases of Military Importance
Resources

Dengue:
Centers for Disease Control (https://www.cdc.gov/dengue/)

Malaria:
Centers for Disease Control (https://www.cdc.gov/parasites/malaria/index.html)

Crimean-Congo hemorrhagic fever:
Centers for Disease Control (https://www.cdc.gov/vhf/crimean-congo/index.html)

Leptospirosis:
Centers for Disease Control (https://www.cdc.gov/leptospirosis/)

Chikungunya:
Centers for Disease Control (https://www.cdc.gov/chikungunya/)

Rickettsiosis:
Centers for Disease Control (https://www.cdc.gov/otherspottedfever/index.html)

Hanta virus:
Centers for Disease Control (https://www.cdc.gov/hantavirus/index.html)

Lassa fever:
Centers for Disease Control (https://www.cdc.gov/vhf/lassa/index.html)

Rift Valley fever:
Centers for Disease Control (https://www.cdc.gov/vhf/rvf/)

Rabies:
Centers for Disease Control (https://www.cdc.gov/rabies/)

Zika:
Centers for Disease Control (https://www.cdc.gov/zika/)

Tick-borne encephalitis:
Centers for Disease Control (https://wwwnc.cdc.gov/travel/diseases/tickborne-encephalitis)

Schistosomiasis:
Centers for Disease Control (https://www.cdc.gov/parasites/schistosomiasis/)

Leishmaniasis:
Centers for Disease Control (https://www.cdc.gov/parasites/leishmaniasis/)

Brucellosis:
Centers for Disease Control (https://www.cdc.gov/brucellosis/)

Q fever:
Centers for Disease Control (https://www.cdc.gov/qfever/)

Japanese encephalitis:
Centers for Disease Control (https://www.cdc.gov/japaneseencephalitis/)

Sandfly fever:

Lyme:
Centers for Disease Control (https://www.cdc.gov/lyme/)

West Nile virus:
Centers for Disease Control (https://www.cdc.gov/westnile/)

Plague:
Centers for Disease Control (https://www.cdc.gov/plague/)
World Health Organization
(https://www.who.int/csr/resources/publications/plague/WHO_CDS_CSR_EDC_99_2_EN/en/)

Typhus (Scrub):
Centers for Disease Control (https://www.cdc.gov/typhus/scrub/index.html)

St Louis encephalitis:
Centers for Disease Control (https://www.cdc.gov/sle/)

Trypanosomiasis (African):
Centers for Disease Control (https://www.cdc.gov/parasites/sleepingsickness/)

Bartonellosis:
Centers for Disease Control (https://www.cdc.gov/bartonella/)

Eastern Equine Encephalitis:
Centers for Disease Control (https://www.cdc.gov/easternequineencephalitis/)

Western Equine Encephalitis:
The Center for Food Security and Public Health
(http://www.cfsph.iastate.edu/Factsheets/pdfs/easter_wester_venezuelan_equine_encephalomyelitis.pdf)

O'nyong-nyong:

Nipah virus:
Centers for Disease Control (https://www.cdc.gov/vhf/nipah/)

Typhus, murine:
Centers for Disease Control (https://www.cdc.gov/typhus/murine/index.html)

Trypanosomiasis (Chagas):
Centers for Disease Control (https://www.cdc.gov/parasites/chagas/index.html)

Mayaro:

Ross River virus:
Ross River Virus Transmission, Infection, and Disease: a Cross-Disciplinary Review (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC89008/)

Yellow fever:
Centers for Disease Control (https://www.cdc.gov/yellowfever/)

Tularemia
Centers for Disease Control (https://www.cdc.gov/tularemia/)

Venezuelan Equine Encephalitis:
United States Department of Agriculture (https://www.aphis.usda.gov/animal_health/emergency_management/downloads/sop/sop_vee_e-e.pdf)

Sinbis virus:

Oropouche:
Oropouche Fever: A Review (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5923469/)

California serogroup viruses:
Centers for Disease Control (https://www.cdc.gov/lac/tech/virus.html)

Barmah Forest virus:
Centers for Disease Control (https://wwwnc.cdc.gov/eid/article/1/1/95-0104_article)

Murray Valley encephalitis:

Alkhurma:
Centers for Disease Control (https://www.cdc.gov/vhf/alkhurma/)

Kyasanur Forest disease
Centers for Disease Control (https://www.cdc.gov/vhf/kyasanur/)

Omsk hemorrhagic fever virus
Centers for Disease Control (https://www.cdc.gov/vhf/omsk/)

Diseases in Humans Caused by Arthropod-borne Viruses
Control of Communicable Diseases Manual 18th Edition
D.L. Heymann – editor
Note – Vector list is not exhaustive. Check multiple sources of information, to include Disease Vector Ecology Profiles, to validate those listed and for additional site-specific vectors

Virus family, genus, group	Name of virus	Vector	Where found
TOGAVIRIDAE			
Alphavirus	Barmah	Primary: *Culex annulirostris* Secondary: *Ochlerotatus vigilax* (New South Wales); *Ochlerotatus camptorhynchus* (Victoria); *Culicoides marksi* in the Northern Territory	Australia
	Chikungunya	Africa: *Ae. aegypti, Ae. africanus, Ae. albopictus, Ae. cordellieri, Ae. furcifer, Ae. fulgens, Ae. luteocephalus, Ae. neoafricanus, Ae. taylori, Ae. vittatus*	North America (US, Mexico), Central and South America (Not Chile and Uruguay); Africa; SE Asia, Europe (Italy, France)
	Eastern Equine encephalomyelitis	Various mosquitoes to include *Culiseta melanura, Coquillettidia pertubans, Aedes sollicitans*, and *Ochlerotatus canadensis; Cx. pedroi and Cx. taeniopus*	Americas
	Mayaro (Uruma)	*Haemagogus* spp. mosquitoes, mainly from *Haemagogus janthinomys* species; *Coquillettidia venezuelensis*	S. America
	O'nyong-nyong	*Anopheles funestus Anopheles gambiae* *Mansonia uniformis*	Africa
	Ross River	Over 40 mosquito vectors to include; *Aedes camptorhynchus*,	Australia, S Pacific

		Aedes notoscriptus, Aedes vigilax, and *Culex annulirostris*	
	Semliki Forest	*Ae. abnormalis*-group, *Ae. argenteopunctatu*	Africa
	Sinbis (Ockelbo, Babanki)	*Aedes spp. Culex spp*. and *Culiseta spp*. Africa: ***Cx. univittatus***, *Cx. neavei, Cx. pipiens, Cx. torrentium, Culiseta morsitans, Coquillettidia fuscopennata* Possibly ticks	Africa, India, SE Asia, Europe, Philippines, Australia, Russian Federation
	Venezuelan equine encephalitis	Numerous mosquito species to include: *Culex ocossa, Cx. panocossa, Cx. vomerifer, Cx. pedroi, Cx. adamesi, Aedes (Ochlerotatus) taeniorhynchus, Culex (Melanoconion) cedecei, Culex (Melanoconion) portesi, Culex (Melanoconion) gnomatos, Aedes (Ochlerotatus) hastatus, Aedes aegypti*	Americas
	Western equine encephalitis	Primary: *Culex tarsalis* Amazon basin*: Aedes hastatus*	Americas
FLAVIVIRIDAE			
Flavivirus	Banzi	Primary: *Culex. rubinotus*	Africa
	Bussuquara	*Aedes spp., Culex spp., Coquillettidia spp., Haemagogus spp., Ochlerotatus spp., Psorophera spp., Sabethes spp., Trichoprosopon spp., Wyeomyia spp.*	S America
	Dengue 1,2,3,4	*Aedes aegypti*	Throughout the tropics
	Edge Hill	*Ochlerotatus vigilax*	Australia
	Ilheus	*Psorophora ferox, Haemagogus janthinomys and Hg. spegazzinii* in Panama and from *Hg. leucocelaenus* in Brazil	Central and S America
	Japanese Encephalitis	*Cx. tritaeniorhynchus, Cx. vishnui, Cx. pseudovishnui, Cx. gelidus, Cx. fuscocephala, Cx. quinquefasciatus, Cx. pipiens pallens, Cx. bitaeniorhynchus, Cx. annulirostris,*	Asia, Pacific Islands, Northern Australia

		Aedes togoi, Ae. japonicus, Ae. vexans nipponii, Anopheles annularis and An. vagus	
	Kokobera	*Culex annulirostris*	Australia
	Koutango	Aedes spp.	Africa
	Kunjin	*Culex annulirostris*	Australia, Sarawak
	Kyasanur Forest disease	*Haemaphysalis spinigera*	India
	Louping Ill	*Ixodes ricinus*	United Kingdom, Western Europe
	Murray Valley encephalitis	Australia: *Culex annulirostris*	Australia, New Guinea
	Negishi	Unknown	Japan
	Omsk hemorrhagic fever	*Dermacentor reticulatus, Dermacentor marginatus, Ixodes persulcatus*	Russian Federation
	Powassan	*Ixodes scapularis* is the primary vector that transmits the virus on the East Coast of US and *Ixodes cookei* in the Midwest and Canada, while *Hemaphysalis longicornis* is the vector in Russia.	Canada, Russian Federation, US
	Rocio	*Psorophora ferox and Aedes scapularis*	Brazil
	Sepik	Mosquito	Papua New Guinea
	Spondweni	*Ae. circumluteolus, Ae. cumminsii, Cx. neavei, Cx. univitattus, Eretmapodites silvestris, Mansonia africana, Mansonia uniformis*	Africa
	St Louis encephalitis	United States: *Cx pipiens* and *Cx quinquefasciatus* in the east, *Cx nigripalpus* in Florida, and *Cx tarsalis* and members of the *Cx pipiens* complex in western states. Argentina: *Culex interfor* and *Culex saltanensis, Cx. quinquefasciatus*	Americas
	Tick-borne encephalitis	Central Europe: *Ixodes ricinus*	Europe
	European sub-type	*Ixodes ricinus* Poland: *Dermacentor reticulatus*	Europe

	Far Eastern sub-type	*Ixodes persulcatus*	Europe, Asia
	Siberian subtype	*Ixodes persulcatus*	Russia
	Usutu	Africa*: Ae. albopictus, Ae. caspius, An. maculipennis, Coquellittidia aurites, Cx. neavei, Cx. perexiguus, Cx. perfuscus, Cx. pipiens, Cx. univittatus, Cx. quinquefasciatus, Mansonia africana*	Africa, Europe
	Wesselsbron	Africa***: Ae. caballus**, **Ae. circumluteolus**, Ae. juppi, Ae. mcintoshi, Ae. luridus, Ae. unidentatus, Ae.* (*Neomelaniconian*) spp., *Cx. univittatus*Mosquito	Africa, SE Asia
	West Nile	Africa: *Cx. modestus, Cx. neavei, Cx. perexiguus, Cx. pipiens, Cx. quinquefasciatus, Cx. univittatus, Cx. theileri*	Africa, North America, Indian subcontinent, Middle east, former Soviet Union, Europe
	Yellow Fever	Primary: *Ae. aegypti* Secondary: *Ae. Albopictus* Africa: *Ae. africanus, Ae. albopictus, Ae. furcifer/taylori, Ae. leucocelaenus, Ae. luteocephalus, Ae. metallicus, Ae. opok, Ae. simpsoni complex, Ae. vittatus, Haemagogus capricorni, Haemagogus equines, Haemagogus janthinomys, Haemagogus leucocelanus, Haemagogus mesodentatus, Haemagogus spegazzinii, Sabethes chloropterus*	Africa, S and Central America
	Zika	Africa*: Ae. aegypti, Ae. africanus, Ae. albopictus, Ae. furcifer, Ae.*	Africa, SE Asia

		jamoti, Ae. opok, Ae. flavicollis, Ae. grahami, Ae. taeniorostris, Ae. tarsalis, Ae. vittatus, Ae. dalziella, Ae. fowleri, Ae. luteocephalus, Ae. metallicus, Ae. minimus, Ae. neoafricanus, An. gambiae, Eretmapodites inornatus, Eretmapodites quinquevittatus, Mansonia uniformis	
BUNYAVIRIDAE			
Bunyavirus			
Group C	Apeu	Amazon basin: *Aedes arborealis, Culex ocossa, Aedes septemstriatus*	S America
	Caraparu	Peru: *Culex gnomatus, Cx. vomerifer, Culex coronator, Culex nigripalpus, Culex ocossa, Culex spissipes, Limatus durhamii, Wyeomyia medioalbipes*	S and Central America
	Itaqui	*Culex ocossa, Culex portesi, Culex spissipes, Culex vomerifer*	S America
	Madrid	Mosquito	Panama
	Marituba	*Culex ocossa, Culex portesi*	S America
	Murutucu	*Coquillettidia venezuelensis, Culex ocossa, Culex portesi, Culex vomerifer*	S America
	Nepuyo	Mosquito	S and Central America
	Oriboca	*Aedes taeniorhynchus, Coquillettidia arribalzagai, Coquillettidia venezuelensis*	S America
	Ossa	*Culex taeniopu, Culex vomerifer*	Panama
	Restan	Mosquito	Trinidad, Suriname
Bunyamwera group	Bunyamwera	*Ae. circumluteolus, Ae. mcintoshi, An. funestus*	Africa
	Germiston	*Cx. rubinotus, Cx. theileri*	Africa
	Ilesha	*Anopheles gambiae, Mansonia uniformis*	Africa
	Tensaw	*Anopheles crucians, Psorophora ciliata, Psorophora confinnis, Anop heles quadrimaculatus, Aedes atlanticus,*	N America

		Aedes mitchellae, Culex nigripalpus, and *Mansonia perturbans*	
Bwamba group	Bwamba	*Anopheles gambiae, Anopheles funestus, Aedes furcifer, Aedes (Neomelanoconion)* spp., *Anopheles coustani, Mansonia uniformis*	Africa
California group	California encephalitis	*Aedes squamiger, Aedes dorsalis*	US
	Guaroa	*Anopheles neivai*	S America, Panama
	Jamestown Canyon	*Ochlerotatus canadensis, Oc. cantator, Anopheles punctipennis, Coquillettidia perturbans, and Oc. abserratus*	US, Canada
	LaCrosse	*Aedes triseriatus*	US
	Snowshoe hare	Mosquito	Canada, China, Russian Federation, US
	Tahyna (Lumbo)	China: *Aedes vexans, Aedes detritus, Culex* spp.	Africa, Asia, Europe
	Trivittatus	*Aedes stimulans, Aedes trivittatus*	N America
Guama group	Catu	*Anopheles nimbus, Coquillettidia venezuelensis. Culex mojuensis*	S America
	Guama	*Culex portesi, Cx. vomerifer, Cx. taeniopus*	S America
Simbu group	Oropouche	*Coquillettidia venezuelensis, Culex quinquefasciatus* *Culicoides* paraensis	S America, Panama
*Phlebovirus (*Sandfly fever group*)*	Candiru	Unknown	S America
	Chagres	Phlebotomine	Central America
	Sandfly Naples type	*Phlebotomus papatasi*	Africa, Asia, Europe
	Punto Toro	Phlebotomine	Panama
	Rift Valley fever	Africa: *Ae. aegypti, Ae. caballus, Ae. cumminsii, Ae. circumluteolus, Ae. dentatus, Ae. juppi, Ae. mcintoshi, Ae.*	Africa, Arabia

		ochraceus, Ae. pembaensis, An. squamosus, Cx. bitaeniorhyncus, Cx. quinquefasciatus, Cx. poicilipes, Cx. theileri, Cx. univittatus, Cx. zombaensis, Eretmapodites quinquevittatus, Mansonia africana, Mansonia uniformis	
	Sandfly Sicilian type	*Phlebotomus papatasi*	Africa, Asia, Europe
	Toscana	*Phlebotomus papatasi*	Italy, Portugal
BUNYAVIRIDAE			
Nairovirus	Nairobi sheep disease	*Rhipicephalus appendiculata* in Africa and *Haemaphysalis intermedia* in India	Africa, India
	Drugbe	Tick	Africa
	Crimean-Congo hemorrhagic fever	*Argas reflexus, Hyalomma anatolicum, Hyalomma detritum, Hyalomma marginatum marginatum* and *Rhipicephalus sanguineus*	Africa, central Asia, Europe, Middle East
Unclassified	Bhanja	Tick	Africa, Asia, Europe
	Tataguine	*Anopheles* spp.	Africa
REOVIRIDAE			
Orbivirus			
Changuinola group	Changuinola	Phlebotomine	Central America
	Kemerovo	*Ixodes persulcatus*	Russian Federation
	Colorado tick fever	*Dermacentor andersoni*	Canada, US
RHABDOVIRIDAE			
Ungrouped	Orungo	*Aedes furcifer-taylori, Aedes luteocephalus*	Africa
	Chandipura	Mosquito	Africa, India
ORTHOMYXOVIRIDAE			

Not classified	Thogoto	Africa: *Rhipicephalus appendiculatus*; *Rhipicephalus decoloratus*	Africa, Europe
	Quaranfil	*Argas arboreus*	Africa, Arabia

Diseases in Humans Caused by Arthropod-borne Bacteria

Bacteria	Type	Name of Disease	Vector
Anaplasma	*Anaplasmosis phagoctophilia*	Anaplasmosis	*Ixodes scapularis, Ixodes pacificus*
Ehrlichia	*Ehrlichia chaffeensis, E. muris eauclairensis*	Ehrlichiosis	*Amblyomma americanum*
	Ehrlichia ewingii	Ehrlichiosis	*Ixodes scapularis*
Bartonella	*Bartonella bacilliformis*	Bartonellosis	*Lutzomyia* spp.
	Oroya fever		*Lutzomyia verrucarum*
	Verrgua peruana		*Lutzomyia verrucarum*
	Bartonella quintana		*Pediculus humanus corporis/ humanus*
	Bartonella henselae		*Ctenocephalides felis*
Borrelia	*Borrelia burgdorferi*	Lyme	*Ixodes scapularis, Ixodes ricinus, Ixodes pacificus*
	Borrelia afzelii	Lyme	*Ixodes ricinus*
	Borrelia garinii	Lyme	*Ixodes ricinus*
Coxiella	*Coxiella burnetii*	Q fever	*Ornithodoros tartakovskyi, O. papillipes, O. alactagalis, Argas persicus, A. reflexus*, and *A. vespertilionis, Hyalomma truncatum, Amblyomma variegatum and Rhipicephalus senegalensis*
Francisella	*Francisella tularensis*	Tularemia	US - *Dermacentor variabilis, Dermacentor andersoni, Amblyomma americanum* *Chrysops spp*
Rickettsia	*Rickettsia rickettsia*	Rocky Mountain spotted fever	*Dermacentor variabilis, D. andersoni, Amblyomma sculptum*[
	Rickettsia conorii	Mediterranean spotted fever	*Rhipicephalus sanguineus*

	Rickettsia slovaca	Spotted fever	*Dermacentor marginatus, D. reticulatus*
	Rickettsia helvetica	Spotted fever	*Dermacentor reticulatus, Ix. ricinus*
Yersinia	*Yersinia pestis*	Plague	
	Bubonic plague		*Xenopsylla cheopis*

Other Vector-borne Diseases

Organism	Type	Name of Disease	Vector
Leishmania	Protozoan	Cutaneous Leishmaniasis	*Phlebotomus* spp.
Leishmania	Protozoan	Visceral Leishmanisis/Kala-azar	*Phlebotomus* spp.
Leishmania	Protozoan	Mucocutaneous	*Phlebotomus* spp.
Plasmodium	Protozoan	*Plasmodium falciparum*	*Anopheles spp*
	Protozoan	*Plasmodium vivax*	*Anopheles spp*
	Protozoan	*Plasmodium ovale*	*Anopheles spp*
	Protozoan	*Plasmodium malariae*	*Anopheles spp*
Filariodidea	Nematode	Lymphatic filiariasis Elephantiasis	*Culex* (in urban and semi-urban areas), *Anopheles* (in rural areas of Africa and elsewhere) and *Aedes* (in islands of the Pacific)
Trypanosoma rhodesiense	Protozoan	East African Sleeping Sickness	*Glossina* spp
Trypanosoma gambiense	Protozoan	West African Sleeping Sickness	*Glossina* spp
Trypanosoma cruzi	Protozoan	Chagas disease	*Triatoma sanguisuga, Triatoma gerstaeckeri, Rhodnius prolixus, Triatoma dimidiata*

Integrated Vector Management

World Health Organization - Handbook for Integrated Vector Management (https://apps.who.int/iris/bitstream/handle/10665/44768/9789241502801_eng.pdf?sequence=1)

Integrated Vector Management for Malaria Control (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2604879/pdf/1475-2875-7-S1-S4.pdf)

Centers for Disease Control – Integrated Mosquito Management (https://www.cdc.gov/westnile/vectorcontrol/integrated_mosquito_management.html)

Centers for Disease Control – Guidelines for Arbovirus Surveillance Programs in the United States (https://www.cdc.gov/ncezid/dvbd/adb/resources/arboguid_508.pdf)

Entomological Risk Assessments

Armed Forces Pest Management Board Technical Guide 46 – DoD Entomological Operational Risk Assessments (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg46.pdf)

Landscape Epidemiology

Landscape epidemiology: An emerging perspective in the mapping and modelling of disease and disease risk factors (https://www.researchgate.net/publication/215590551_Landscape_epidemiology_An_emerging_perspective_in_the_mapping_and_modelling_of_disease_and_disease_risk_factors)

Landscape Epidemiology of Emerging Infectious Diseases in Natural and Human-Altered Ecosystems (file:///H:/_MyComputer/Desktop/Climate%20change/LandscapeepidemiologyAnemergingperspectiveinthemappin....pdf)

Zoonotic Disease
(w/o Arthropod Vector)

Zoonotic diseases also called zoonoses are infectious diseases that can be spread from animals to humans. There are many zoonotic diseases, and their threat to human health is growing due to increasing global movement of people and animals and the effects of human populations expanding into previously undeveloped wildlife habitats. In addition, zoonotic diseases such as rabies, leptospirosis, Lyme disease, Chagas disease, leishmaniasis, scabies, and a variety of intestinal parasites are potential health risk to MWDs. Some zoonotic diseases are transmitted directly from animals to people, some result from contamination of the environment by animals, and others require a vector such as tick or mosquito.

Centers for Disease Control – zoonotic diseases (https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html)

Centers for Disease Control – Prioritizing Zoonotic Diseases for Multi-sectoral, One Health Collaboration in the United States (https://www.cdc.gov/onehealth/pdfs/us-ohzdp-report-508.pdf)

American Biological Safety Association - Zoonotic Diseases Fact Sheet (https://absa.org/wp-content/uploads/2017/01/ZoonoticFactSheet.pdf)

Hantavirus/ Hemorrhagic Fever with Renal Syndrome/Hanta Pulmonary Syndrome

Hantaviruses are a family of viruses spread mainly by rodents and can cause varied disease syndromes in people worldwide. Infection with any hantavirus can produce hantavirus disease in people. Hantaviruses in the Americas are known as "New World" hantaviruses and may cause hantavirus pulmonary syndrome (HPS). Other hantaviruses, known as "Old World" hantaviruses, are found mostly in Europe and Asia and may cause hemorrhagic fever with renal syndrome (HFRS). Each hantavirus serotype has a specific rodent host species and is spread to people via aerosolized virus that is shed in urine, feces, and saliva, and less frequently by a bite from an infected host. The most important hantavirus in the United States that can cause HPS is the Sin Nombre virus, spread by the deer mouse.

Centers for Disease Control – Hanta Virus (https://www.cdc.gov/hantavirus/index.html)
California Department of Public Health – Hantavirus Tool Kit (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/HantaToolkit.aspx)
Centers for Disease Control – Methods for Trapping and Sampling Small Mammals for Virologic Testing (https://www.cdc.gov/hantavirus/pdf/rodent_manual.pdf)

Lassa Fever (*Lassa mammarenavirus*)

Lassa fever is an animal-borne, or zoonotic, acute viral illness. It is endemic in parts of West Africa including Sierra Leone, Liberia, Guinea and Nigeria. Neighboring countries are also at risk, as the animal vector for Lassa virus, the "multimammate rat" (*Mastomys natalensis*) is

distributed throughout the region. The illness was discovered in 1969 and is named after the town in Nigeria where the first cases occurred.

Centers for Disease Control - Lassa Fever (https://www.cdc.gov/vhf/lassa/index.html)

Leptospirosis (*Leptospira interrogans*)
The bacteria that cause leptospirosis are spread through the urine of infected animals, which can get into water or soil and can survive there for weeks to months. Many different kinds of wild and domestic animals carry the bacterium.

These can include, but are not limited to:
Cattle
Pigs
Horses
Dogs
Rodents
Wild animals
When these animals are infected, they may have no symptoms of the disease.

Infected animals may continue to excrete the bacteria into the environment continuously or every once in a while for a few months up to several years.
Humans can become infected through:

Contact with urine (or other body fluids, except saliva) from infected animals.
Contact with water, soil, or food contaminated with the urine of infected animals.

The bacteria can enter the body through skin or mucous membranes (eyes, nose, or mouth), especially if the skin is broken from a cut or scratch. Drinking contaminated water can also cause infection. Outbreaks of leptospirosis are usually caused by exposure to contaminated water, such as floodwaters. Person to person transmission is rare.

Centers for Disease Control – Leptospirosis (https://www.cdc.gov/leptospirosis/index.html)

Q Fever (*Coxiella burnetii*)
Q fever is a disease caused by the bacteria *Coxiella burnetii*. This bacteria naturally infects some animals, such as goats, sheep, and cattle. *C. burnetii* bacteria are found in the birth products (i.e. placenta, amniotic fluid), urine, feces, and milk of infected animals. People can get infected by breathing in dust that has been contaminated by infected animal feces, urine, milk, and birth products. Some people never get sick; however, those who do usually develop flu-like symptoms including fever, chills, fatigue, and muscle pain.

Centers for Disease Control – Q Fever (https://www.cdc.gov/qfever/)

Rabies (Rhabdoviridae, *Lyssavirus)*
Rabies is a fatal but preventable viral disease. It can spread to people and pets if they are bitten or scratched by a rabid animal. In the United States, rabies is mostly found in wild animals like

bats, raccoons, skunks, and foxes. However, in many other countries dogs still carry rabies, and most rabies deaths in people around the world are caused by dog bites.
The rabies virus infects the central nervous system. If a person does not receive the appropriate medical care after a potential rabies exposure, the virus can cause disease in the brain, ultimately resulting in death. Rabies can be prevented by vaccinating pets, staying away from wildlife, and seeking medical care after potential exposures before symptoms start.

Centers for Disease Control – Rabies (https://www.cdc.gov/rabies/index.html)
Armed Forces Pest Management Board Technical Guide 3 – Feral Animal Risk Mitigation in Operational Areas (https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg3.pdf)
Armed Forces Pest Management board Technical Guide 37 – Integrated Management of Stray Animals on Military Installations (https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg37.pdf)

Schistosomiasis (*Schistosoma mansoni, S. haematobium, S. japonicum, S. mekongi* and *S. intercalatum*)
Schistosomiasis, also known as bilharzia, is a disease caused by parasitic worms. Although the worms that cause schistosomiasis are not found in the United States, people are infected worldwide. In terms of impact this disease is second only to malaria as the most devastating parasitic disease. Schistosomiasis is considered one of the neglected tropical diseases (NTDs). The parasites that cause schistosomiasis live in certain types of freshwater snails. The infectious form of the parasite, known as cercariae, emerge from the snail into the water. You can become infected when your skin comes in contact with contaminated freshwater. Most human infections are caused by *Schistosoma mansoni, S. haematobium,* or *S. japonicum*.

Centers for Disease Control – Schistosomiasis (https://www.cdc.gov/parasites/schistosomiasis/)

One Health Concept

One Health is a collaborative, multi-sectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment. The One Health approach reaches beyond addressing infectious disease threats in humans and animals. The interconnectedness between changes in climate, land use, population dynamics, foreign policy, biosecurity, economics, trade, agriculture, and natural resources are important. CDC's One Health Office leads the agency's One Health efforts in the United States and abroad.

Centers for Disease Control (https://www.cdc.gov/onehealth/index.html)

United States Department of Agriculture, Animal and Plant Health Inspection Service (https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/SA_One_Health)

National Invasive Species Council, Invasive Species Advisory Committee – The interface between invasive species and the increased incidence of tick-borne disease, and the implications for federal land managers (https://extranet.acq.osd.mil/eie/afpmb/cac/ticks/tick_reference/The%20interface%20between%20invasive%20species%20and%20the%20increased%20incidence%20of%20tick-borne%20diseases,%20and%20the%20implications%20for%20federal%20land%20managers.pdf)

Urban Pests

Ant Resources

Identification/Bionomics
FMC Ant Identification Guide (http://www.fmcprosolutions.com/LinkClick.aspx?fileticket=dsESXNRwKA0%3D&tabid=1232&mid=2082)
PestWorld.org (https://www.pestworld.org/pest-guide/ants/)

Surveillance/Management
Armed Forces Pest Management Board Technical Guide 29 – Integrated Pest Management In and Around Buildings (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf)
PestWorld.org (https://www.pestworld.org/pest-guide/ants/)
Urban Integrated Pest Management
https://nepis.epa.gov/Exe/ZyPDF.cgi/9100HM7M.PDF?Dockey=9100HM7M.PDF

Bed bug (*Cimex lectularius/Cimex pilosellus*) Resources

Identification/Bionomics
Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)
Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance - Bugs: Pictorial Key to Some Species that May Bite (https://www.cdc.gov/nceh/ehs/docs/pictorial_keys/Bugs.pdf)

Surveillance/Management
Armed Forces Pest Management Board Technical Guide 29 – Integrated Pest Management in and Around Buildings (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf)
Armed Forces Pest Management Board Technical Guide 44 – Bed Bugs – Importance, Biology, and Control Strategies (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg44.pdf) and Supplemental Information (https://www.acq.osd.mil/eie/afpmb/docs/techguides/Supplemental_BedBug_Info.zip)
Urban Integrated Pest Management
https://nepis.epa.gov/Exe/ZyPDF.cgi/9100HM7M.PDF?Dockey=9100HM7M.PDF

Cockroach Resources

Identification/Bionomics
Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Surveillance/Management
Armed Forces Pest Management Board Technical Guide 29 – Integrated Pest Management in and Around Buildings (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf)
Urban Integrated Pest Management
https://nepis.epa.gov/Exe/ZyPDF.cgi/9100HM7M.PDF?Dockey=9100HM7M.PDF

Lice (*Pediculus humanus capitis*/*Phthirus pubis*) Resources

Identification/Bionomics
Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)
Centers for Disease Control – Head Lice (https://www.cdc.gov/parasites/lice/head/index.html)
Centers for Disease Control – Pubic Lice (https://www.cdc.gov/parasites/lice/pubic/index.html)

Surveillance/Management
Armed Forces Pest Management Board Technical Guide 6 – Delousing Procedures for Contingency Operations (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg6.pdf)
Centers for Disease Control – Head Lice (https://www.cdc.gov/parasites/lice/head/index.html)
Centers for Disease Control – Pubic Lice (https://www.cdc.gov/parasites/lice/pubic/index.html)
Urban Integrated Pest Management
https://nepis.epa.gov/Exe/ZyPDF.cgi/9100HM7M.PDF?Dockey=9100HM7M.PDF

Stored Product Pests Resources

Identification/Bionomics

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)
United States Department of Agriculture, Insect and Mite Pests in Food (Volume 1): https://www.ars.usda.gov/ARSUserFiles/2863/pdfdocuments/Gorham%201991%20V1.pdf
United States Department of Agriculture, Insect and Mite Pests in Food (Volume 2): https://www.ars.usda.gov/ARSUserFiles/2863/pdfdocuments/Gorham%201991%20V2.pdf

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 27 – Stored Product Pests Monitoring Methods (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg27.pdf)
Kansas State University, Stored Product Protection (https://bookstore.ksre.ksu.edu/pubs/S156.pdf)
United States Department of Agriculture, New Pest Guidelines: Khapra Beetle (https://www.aphis.usda.gov/import_export/plants/manuals/emergency/downloads/nprg-khapra.pdf)
Urban Integrated Pest Management
https://nepis.epa.gov/Exe/ZyPDF.cgi/9100HM7M.PDF?Dockey=9100HM7M.PDF

Rodent Resources

Identification/Bionomics

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Surveillance/Management

Centers for Disease Control, Integrated Pest Management: Conducting Urban Rodent Surveys (https://www.cdc.gov/nceh/ehs/docs/IPM_Manual.pdf)
Centers for Disease Control – Rodents (https://www.cdc.gov/rodents/index.html)
Armed Forces Pest Management Board Technical Guide 29 – Integrated Pest Management in and Around Buildings (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf)
Centers for Disease Control – Integrated Pest Management: Conducting Urban Rodent Surveys (https://www.cdc.gov/nceh/ehs/docs/ipm_manual.pdf)
Urban Integrated Pest Management
https://nepis.epa.gov/Exe/ZyPDF.cgi/9100HM7M.PDF?Dockey=9100HM7M.PDF

Spider Resources

Identification/Bionomics

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance (https://www.cdc.gov/nceh/ehs/publications/pictorial_keys.htm)

Centers for Disease Control, Pictorial Keys to Arthropods, Reptiles, Birds, and Mammals of Public Health Significance - Spiders: Key to Some Important United States Species (https://www.cdc.gov/nceh/ehs/docs/pictorial_keys/Spiders.pdf)

Surveillance/Management

Armed Forces Pest Management Board Technical Guide 29 – Integrated Pest Management in and Around Buildings (https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf)

Urban Integrated Pest Management
https://nepis.epa.gov/Exe/ZyPDF.cgi/9100HM7M.PDF?Dockey=9100HM7M.PDF

Wildlife and Feral Animal Resources

Armed Forces Pest Management Board Technical Guide 3 – Feral Animal Risk Mitigation in Operational Areas (https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg3.pdf)

Armed Forces Pest Management board Technical Guide 37 – Integrated Management of Stray Animals on Military Installations
(https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg37.pdf)

University of Nebraska, The Handbook: Prevention and Control of Wildlife Damage
(https://digitalcommons.unl.edu/icwdmhandbook/)

Wildlife Damage Management - https://wildlife-damage-management.extension.org/

Climate Change (General Information – Impact on Pests and Disease Vectors)

Department of Defense – Report on Effects of a Changing Climate to the Department of Defense (DoD)(https://media.defense.gov/2019/Jan/29/2002084200/-1/-1/1/CLIMATE-CHANGE-REPORT-2019.PDF)

U.S. Global Change Research Program/Department of Defense (https://www.globalchange.gov/agency/department-defense)

Government Accountability Office (GAO) Report (GAO-19-453): DoD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Designs (https://www.gao.gov/assets/700/699679.pdf)

Centers for Disease Control – Diseases Carries by Vectors (https://www.cdc.gov/climateandhealth/effects/vectors.htm)

Centers for Disease Control - Climate Change and Vector-borne/Zoonotic Diseases (https://www.astho.org/programs/environmental-health/natural-environment/climate-change-and-vector-borne-diseases/)

Climate change and vector-borne diseases: what are the implications for public health research and policy? (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4342958/)

Climate Adaptation for DoD Natural Resources Managers (https://www.denix.osd.mil/nr/dodadaptationguide/)

The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment, Chapter 5, Vector-Borne Diseases (https://health2016.globalchange.gov/vectorborne-diseases)

Biosecurity (General Information – Regional Biosecurity Plan for Micronesia and Hawaii)

National Invasive Species Council regional Biosecurity Plan for Micronesia and Hawaii Fact Sheet (https://www.doi.gov/sites/doi.gov/files/uploads/rbp_fact_sheet.pdf)

Naval Facilities Engineering Command Regional Biosecurity Plan for Micronesia and Hawaii (https://www.navfac.navy.mil/navfac_worldwide/pacific/about_us/regional-biosecurity-plan-for-micronesia-and-hawaii-.html)

Emerging Vector Control/Pest Management Technologies

Self-destructing mosquitoes and sterilized rodents: the promise of gene drives (https://www.nature.com/articles/d41586-019-02087-5)

Mosquitoes armed with bacteria beat back dengue virus (https://www.sciencemag.org/news/2019/11/mosquitoes-armed-bacteria-beat-back-dengue-virus)

Combating mosquito-borne diseases with bacteria (https://www.sciencedaily.com/releases/2019/06/190610130115.htm)

Vector-borne Disease Response Examples

California Department of Public Health

Mosquitoes and Mosquito-Borne Diseases (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/MosquitoesandMosquitoBorneDiseases.aspx)

Aedes aegypti and *Aedes albopictus* mosquitoes (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Aedes-aegypti-and-Aedes-albopictus-mosquitoes.aspx#)

Tick-Borne Diseases (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Tick-Borne-Diseases.aspx)

Connecticut State Mosquito Trapping and Arbovirus Testing Program (https://portal.ct.gov/CAES/Mosquito-Testing/Introductory/State-of-Connecticut-Mosquito-Trapping-and-Arbovirus-Testing-Program

Centers for Disease Control – Multistate Outbreak of Eastern Equine Encephalitis Virus/United States 2019 (https://www.cdc.gov/mmwr/volumes/69/wr/pdfs/mm6902a4-H.pdf)

National Association of County and City Health Officials (NACCO) - Four Common Oversights Government Officials Make With Mosquito Management (http://www.vdci.net/mosquito-management-online-class)

National Association of County and City Health Officials (NACCO) - Leveraging One Health Collaborations to Enhance Investigation Capacity (http://essentialelements.naccho.org/archives/16033)

National Association of County and City Health Officials (NACCO) – Tick-borne Diseases Webinar Recording (http://essentialelements.naccho.org/archives/13750)

Journal of Medical Entomology - Special Collection: Twenty Years of West Nile Virus in the United States (https://academic.oup.com/jme/pages/twenty-years-of-west-nile-virus-in-the-united-state)

Global Health Engagement

Military Health System Global Health Engagement (https://www.health.mil/Military-Health-Topics/Health-Readiness/Global-Health-Engagement)

Center for Global Health Engagement (https://www.usuhs.edu/cghe)

Continued Learning Resources
Webinars

America Mosquito Control Association Webinars (Members only)
https://www.mosquito.org/page/webinars

Association of State and Territorial Health Officials:
https://astho.org/Webinars/

Centers for Disease Control Webinars – Periodically updated with new content. Subscribe to the series: https://tools.cdc.gov/medialibrary/index.aspx#**)**
-Anaplasmosis in Maine: https://tools.cdc.gov/podcasts/media/mp3/EID_02-20_AnaplasmososMaine.mp3
-Communicating Complicated Science: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/405607
-Lyme Disease and Connected Landscapes, New York City: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/401093
-Monitoring Chikungunya with Big Data: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/399493
-Risk Communication for Ebola Outbreak in Sierra Leone: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/393308
-Tickborne Ehrlichia in North Carolina: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/393173
-History of Mosquito-borne Diseases in the United States: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/381284
-Sympatric Ehrlichiosis and Lyme Disease in New Jersey: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/338831
-Treatment Failure for Malaria in Vietnam: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/335086
-Two Decades of Hantavirus: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/335087
-Plague in Yosemite: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/306717
-Resurgence of Yellow Fever in Angola, 2015-2016: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303905
-Dengue Returns: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303887
-Controlling Mosquitoes Indoors: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303883
-Controlling Mosquitoes Outside: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303869
-A Tick on the Move: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303867
-Threat form Emerging Vector-borne Viruses: https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303842
-History of Mosquito-borne Disease in the United States and Implications for New Pathogens https://wwwnc.cdc.gov/eid/article/24/5/17-1609_article

-Louse-borne Relapsing Fever in Europe:
https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303527
-Chagas Disease: No Longer Exotic:
https://tools.cdc.gov/medialibrary/index.aspx#/media/id/303284
-Emerging Infectious Diseases Series:
https://tools.cdc.gov/medialibrary/index.aspx#/podcastseries/id/302084
Diseases of the Week (https://tools.cdc.gov/medialibrary/index.aspx#/feed/id/132500) **–**
Subscribe to the feed (https://tools.cdc.gov/medialibrary/index.aspx#)

Collaborative on Health and the Environment
Webinar - https://www.healthandenvironment.org/webinars/96503

Climate change is creating suitable conditions for the increased spread and virulence of infectious diseases caused by harmful pathogens including bacteria, viruses, fungi, protozoa, and parasites. Vector-borne illnesses and fungal diseases are just two of many that are extending to new areas and becoming more prevalent, threatening human health.

Zika, dengue, chikungunya, malaria, Lyme disease, bluetongue, Shmallenberg are vector-borne diseases with huge impacts on societies and they are omnipresent in the news. These diseases are transmitted by exothermic arthropod vectors such as mosquitoes, midges and ticks, which are extremely sensitive to external environmental conditions. Rainfall is an important factor as it provides breeding sites for larvae. Temperature impacts a broad range of factors such as vector development, its survival, vector biting rates and the time required for the pathogen to develop inside the arthropod vector. Consequently, anthropogenic climate change is expected to greatly impact the distribution and severity of these vector-borne diseases. During this webinar Dr. Cyril Caminade presented recent advances in our understanding of climate change impacts on animal and human vector-borne diseases.

Cornell University
- Surveillance Practices in the Northeast Webinar:
(https://ecommons.cornell.edu/handle/1813/69534)
-Discussion on the Invasive Asian Longhorned Tick, *Haemaphysalis longicornis*:
(https://ecommons.cornell.edu/handle/1813/60512)
-Concepts Vector Control: Ticks (https://ecommons.cornell.edu/handle/1813/58781)

Ecolab Webinars: https://www.ecolab.com/media-center/on-demand-webinars
-Learn How to Reduce Your Risk of Bed Bugs -
https://www.ecolab.com/events/2018/07/reduce-your-risk-of-bed-bugs
-Impact of Small Flies on Food Safety: https://www.ecolab.com/events/2018/06/the-impact-of-small-flies-on-food-safety
-Rodents: The Impact of Pests on Food Safety: https://www.ecolab.com/events/2017/10/rodents-the-impact-of-pests-on-food-safety
-Cockroaches: The Impact of Pests on Food Safety:
https://www.ecolab.com/events/2017/08/cockroaches-the-impact-of-pests-on-food-safety

-Large Flies: Strategies to Reduce Risk - https://www.ecolab.com/events/2017/06/large-flies-strategies-to-reduce-risk

Environmental Protection Agency
-Webinars about Integrated Pest Management in Schools: https://www.epa.gov/managing-pests-schools/webinars-about-integrated-pest-management-schools
-Managing Rats and Mice at Schools (Dr. Dawn Gouge – University of Arizona and Bobby Corrigan) https://s3.wp.wsu.edu/uploads/sites/415/2014/12/ManageingRatsPPT.pdf

Extension Learn: https://learn.extension.org/
Don't bug me Webinar – Ants! Ants! Ants! https://learn.extension.org/events/836

National Association of County and City Health Officials (NACCHO)
(https://www.naccho.org/membership**) – Sign up for a membership**
-Community of Practice Discussion (Vector Control)
-Vector Control Toolkit
-Webinars

National Pest Management Association
Webinar Series **(**https://npmapestworld.org/member-center/on-demand/)
BugBytes (http://www.npmabugbytes.org/): NPMA's original podcast channel features engaging interviews with industry icons and researchers. Learn about the latest in science and technology impacting the pest management industry today!
NPMA360 (https://www.youtube.com/gcds-iap/unavailable.html): NPMA360 is a virtual reality training series that delivers a state of the art training experiences to any mobile device or computer. Don't forget to subscribe to be sure you never miss an episode!

Northeastern IPM Center (https://www.northeastipm.org/index.cfm)
Northeastern IPM Center "The IPM Toolbox" Webinar Recordings - https://www.northeastipm.org/ipm-in-action/the-ipm-toolbox/webinar-recordings/
Stop Pests in Housing Webinars (http://www.stoppests.org/ipm-training/training-opportunities/stoppests-webinars/)

Northeast Regional Center for Excellence in Vector-borne Diseases (https://www.neregionalvectorcenter.com/)
-Vector Boot Camp: https://www.neregionalvectorcenter.com/vector-biology-boot-camp. The Vector Biology Boot Camp is an annual event offered by the Northeast Regional Center for Excellence in Vector-Borne Diseases and the Louis Calder Center of Fordham University, providing hands-on learning opportunities in vector surveillance program operations.

The program is designed for vector-borne disease professionals working in the Northeast, covering tick and mosquito species of medical importance to this region. Ideal program applicants include professionals whose job duties specifically involve vector surveillance and/or control.

-Online Programs: https://www.neregionalvectorcenter.com/online-programs

NEVBD works with experts across the Northeast and US to produce free webinars on topics important to professionals working to control mosquito- and tick-borne diseases in our region.

-Concepts in Vector Control: Ticks
-Discussions on the Invasive Asian Longhorned Tick, *Haemaphysalis longicornus*
-Tick Surveillance Practices in the Northeast

Pacific Southwest Center for Excellence in Vector-borne Diseases (https://pacvec.us/)
-Seminar Series (https://pacvec.us/seminars/)

2018
-How does Bti cause toxicity to mosquitoes?
-Let the mozzies losse: a tale of two Wolbachias
-Adaptation of Anopheles mosquitoes to human habitats and vector control
-Model-based projections of Zika virus infections: diverse epidemiological applications of a new method
-Microorganisms as sources of proteins for highly effective mosquito control
-Predicting efficacy of field adulticiding from laboratory assays for insecticide resistance
-The piRNA system of *Aedes aegypti* and its possible role in viral immunity and transposon silencing: a new route to immune priming?
-Overview of the Pacific Southwest Center of Excellence in Vector-borne Disease
-Changing ecology of Rocky Mountain spotted fever
-Overview of the Pacific Southwest Center of Excellence in Vector-borne Disease

2019
-Constructed Wetlands: Does Improving Water Quality Jeopardize Public Health?
-The Midwest Center of Excellence in Vector-borne Diseases: Challenges and Opportunities
-A Systems Biology Approach to Understand Gene Regulation and Pathogenicity in Human Malaria Parasites
-Repeat Performances: Clinical and Epidemiological Aspects of Tick-borne Relapsing Fever in California

Rutgers Center for Vector Biology (http://vectorbio.rutgers.edu/outreach/courses.php)
Mosquito Biology Courses
The center offers, through the Office of Continuing Professional Education, courses to further the development of the professional mosquito control worker. Workshops offered include:Photo of class in swamp.

Mosquito Biology & Control

Mosquito Habitat Recognition

Mosquito Identification - People can obtain a discount by signing up for all three of the above classes. For further information, contact Diana Carle at dianacarle@gmail.com

University of Florida – Pest Management University
(https://pestmanagementuniversity.org/course/online-webinar-series)

From April to June 2020 PMU will be offering a FREE webinar series hosted by leading experts in the pest management industry. These will be 1-hour webinars held on Tuesdays.

Tuesday, April 14, 2020 – Dini Miller, Virginia Tech. Why IPM has failed to eliminate German Cockroaches
Tuesday, April 21, 2020 – Bobby Corrigan, Consultant. Urban Rodents
Tuesday, April 28, 2020 – Paul Mitola, Florida Department of Agriculture. CORE
Tuesday, May 5, 2020 – Kemp Anderson, Kemp Anderson Consulting. Leading Your Business
Tuesday, May 12, 2020 – Stan Cope, AP&G. Why Mosquito Control in Essential
Thursday, May 21, 2020 – Brian Forschler, University of Georgia. Termites
Tuesday, May 26, 2020 – Paul Mitola, Florida Department of Agriculture. CORE
Tuesday, June 2, 2020 – Chris Marble, University of Florida. Weeds.
Tuesday, June 9, 2020 – Adam Dale, University of Florida. Landscape IPM.
Tuesday, June 16, 2020 – Thomas Chouvenc, University of Florida. Termites

University of Georgia Extension – Structural Pest Management Webinars
(https://extension.uga.edu/programs-services/structural-pest-management/webinars.html)

University of Rhode Island Tick Encounter: Webinars
(https://tickencounter.org/resources/webinars)

Public Health/Pest Management Training Opportunities

American Mosquito Control Association (https://www.mosquito.org/)
Mosquito Surveillance and Control Program e-Modules:
https://www.mosquito.org/page/EModules
The e-modules cover basic mosquito biology, surveillance and control with an emphasis on *Aedes aegypti* and *Aedes albopictus.* These modules serve as an on-site supplement and complement the onsite training hubs in four key areas to build capacity in the workforce:

Module 1: Mosquitoes and Disease: *Aedes* and *Culex*;

Module 2: What and Why of *Aedes* Species Ecology and Behavior;

Module 3: The What and How of *Aedes* Surveillance; and

Module 4: The What and How of *Aedes* Control

Centers for Disease Control TRAIN Learning Network
(https://www.train.org/cdctrain/home)

Centers for Disease Control and Prevention/Tulane University School of Public Health and Tropical Medicine Vector Control for Environmental Health Professionals (VCEHP)
(https://www.cdc.gov/nceh/ehs/elearn/vcehp.html)
Environmental health professionals are on the frontline of helping individuals, institutions, and communities reduce threats from mosquitoes, ticks, and other vectors. This training—Vector Control for Environmental Health Professionals—emphasizes the use of integrated pest management to address public health pests and vectors that spread pathogens, including Zika virus and others.

The training includes 11 courses. Take all of them or pick and choose (the first three are required, then take courses in any order):

Vector-Borne Diseases of Public Health Importance
Integrated Pest Management Basics
Performance Assessment and Improvement of Vector Control Services
Tick Biology and Control
Mosquito Biology and Control
Toxicology of Pesticides
Rodent Management
Pests and Vectors in Food and Housing Environments
Special Pest Management Considerations for Schools
Risk Communication Basics
Bed Bug Biology and Control

Georgia Southern University - United States National Tick Collection
CDC Southeastern Center of Excellence in Vector-borne Diseases Tick Workshop
(https://cosm.georgiasouthern.edu/usntc/center-of-excellence-tick-workshop-2020/)

London School of Hygiene and Tropical Medicine: The Global Challenge of Vector Borne Diseases and How to Control Them

-This innovative and exciting six-week free online course will allow participants to explore the wide range of vectors and the diseases they transmit and learn about traditional and modern vector control. The course will cover state of the art vector control and importantly, participants will also learn about the suitability of vector control practices in the world today.

Using videos, presentations, articles and discussions, participants will hear from a wide range of world-leading experts from around the world, and across disciplines including epidemiology, entomology, vector biology, social science and health systems.

The course is specifically designed for anyone with an interest in vector borne diseases and public health. We particularly encourage those working in global and public health to enroll; including government stakeholders, health workers, those working on vector control programs, vector researchers and industry employees. https://www.futurelearn.com/courses/vector-borne-diseases?utm_campaign=lshtm_vectors&utm_medium=pr&utm_source=pr

Midwest Center of Excellence for Vector-borne Disease

-Certification in Public Health Entomology by the Midwest Center of Excellence in Vector-borne Diseases (MCE-VBD): The MCE-VBD is offering a certificate in Public Health Entomology to recognize and provide basic skills related to the surveillance and management of mosquito- and tick-borne diseases. The certification process is open to anyone affiliated with MCE-VBD partner organizations with interest in developing skills in vector-borne disease surveillance and control. http://mcevbd.wisc.edu/training-programs/certificate-in-public-health-entomology

Southeastern Regional Center of Excellence for Vector-borne Disease

-Mosquito Training Course for Pest Managers by IFAS and SEVBD: Our Center of Excellence, along with partners in the University of Florida's Institute of Food and Agricultural Sciences, is pleased to announce a new online course in mosquito training for pest managers. Participants who complete the 11 modules in the course will learn to identify and understand the mosquitoes of major importance in the urban environment, their life cycles, the general methods of control, personal protective equipment required for safe insecticide application, and the laws and regulations governing mosquito control for the urban pest management industry. https://ifas-mosquitoceus.catalog.instructure.com/courses/mosqtraining

-Vector Control for Environmental Health Professionals (VCEHP): A no-cost 11-course learning series developed by the Centers for Disease Control and Prevention and partners. Program emphasized the use of integrated pest management (IPM) to address public health pests and vectors that spread disease. https://lms.southcentralpartnership.org/vcehp.php

University of Arkansas Acarology Summer Program (https://training.uark.edu/professional-development/courses/acarology-summer-program.php)

Medical-Veterinary Acarology

This two-week workshop will review the various Acari associated with humans and domestic animals. Unlike previous years, we will not have a full week on ticks and tick diseases. Week one will have a concentrated 2-3 days on tick systematics and identification and then the remaining 1.5 weeks will extensively examine all the other groups of vertebrate parasitic mites. This will include discussions of various Mesostigmata, including ectoparasites and nasal mites, Astigmata, including feather mites, Trombiculoidea (chiggers), and miscellaneous Prostigmata

University of Florida/IFAS Florida Medical Entomology Laboratory Advanced Mosquito Identification and Certification (https://fmel.ifas.ufl.edu/general-information/advanced-mosquito-identification-and-certification/)

The Advanced Mosquito Identification and Certification Course is a two-week intensive training on the species-level identification of the mosquitoes of North America. The course is held in March each year at the Florida Medical Entomology Laboratory (UF/IFAS) in Vero Beach, FL. Week 1 focuses on identification of adult female mosquitoes. Week 2 focuses on identification of mosquito larvae. Each week culminates in written and practical exams. Combined grades of 70% must be achieved in order to receive UF/IFAS/FMEL Certification as a Certified Mosquito Identification Specialist. Attending the course does not guarantee certification. All attendees receive certificates of attendance. This is not an introductory course. Students should have prior knowledge of Mosquito Morphology and be familiar with stereo and compound microscopes as well as insect identification keys.

Epidemiology Training

Merck Veterinary Manual – Basic Principles of Epidemiology
(https://www.merckvetmanual.com/public-health/public-health-primer/basic-principles-of-epidemiology)

Northwest Center for Public Health Practice - Basic Infectious Disease Concepts in Epidemiology (http://www.nwcphp.org/training/basic-infectious-disease-concepts-in-epidemiology)

Principles of Epidemiology in Public Health Practice – Self Study Course:
https://www.cdc.gov/csels/dsepd/ss1978/ss1978.pdf

CDC Epidemiology Training and Resources (https://www.cdc.gov/eis/request-services/epiresources.html)

Landscape Epidemiology of Vector-Borne Diseases (https://www.annualreviews.org/doi/full/10.1146/annurev-ento-112408-085419?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub++0pubmed)

Risk Communication

World Health Organization Risk Communication (https://www.who.int/emergencies/risk-communications). For public health emergencies, risk communication includes the range of communication capacities required through the preparedness, response and recovery phases of a serious public health event to encourage informed decision making, positive behavior change and the maintenance of trust.

Risk communication used to be viewed primarily as the dissemination of information to the public about health risks and events, such as outbreaks of disease and instructions on how to change behavior to mitigate those risks. Thinking on this has now evolved dramatically as social science evidence and new communication and media technologies and practices have evolved in the 21st century.

Centers for Disease Control Emergency Preparedness and Response (CERC) (https://emergency.cdc.gov/cerc/training/index.asp) Crisis and Emergency Risk Communication (CERC) training can help responders and public health professionals prepare to communicate in an emergency. The CERC program offers training in online, webinar, and in-person formats.

Centers for Disease Control Emergency Preparedness and Response (CERC) Webinars (https://emergency.cdc.gov/cerc/training/archives.asp) Crisis and Emergency Risk Communication (CERC) training can help responders and public health professionals prepare to communicate in an emergency. CERC trainings are based on lessons learned during public health emergencies, evidence-based practices from the fields of risk and crisis communication, and psychology. The CERC program offers training in online, webinar, and in-person formats.

National Oceanic and Atmospheric Administration (NOAA) – Risk Communication Basics
https://coast.noaa.gov/digitalcoast/training/risk-communication-guidebook.html
A key element of communicating effectively about risk is identifying the audience's diverse values and concerns and using that information to design a communication approach. The goal is a high level of community engagement—and action. This publication helps community leaders understand and connect with stakeholders and inspire risk-wise behavior through improved communication.

Topics include

How and why people perceive risk differently
How to learn more about your audience
Best practices for risk communication
Ways to frame your conversations to appeal to a variety of audiences
Sample conversations for responding to difficult questions

National Oceanic and Atmospheric Administration (NOAA) – Seven Best Practices for Risk Communication (Self-guided Module)(https://coast.noaa.gov/digitalcoast/training/best-practices-module.html)

Whether beginning a new effort or trying to keep people motivated to better prepare for future hazards, applying risk communication principles will lead to more effective results. This self-guided module introduces seven best practices, numerous techniques, and examples to help you improve your communication efforts. Knowledge checks and a final quiz are included to help you retain what you learn.

Army Public Health Center – Health Risk Communication Training (https://phc.amedd.army.mil/topics/envirohealth/hrc/Pages/Health-Risk-Communication-Training.aspx):
This entry level course provides participants with a basic understanding of the concepts, principles and processes of effective risk communication. Participants learn to anticipate and address public and/or worker concerns that affect mission success. Research-based risk communication principles can help manage concerns related to:

Health
Environment
Deployment
Homeland Security
Occupation

Navy and Marine Corps Public Health Center (NMCPHC) (https://www.med.navy.mil/sites/nmcphc/environmental-programs/Pages/risk-communication.aspx)
NMCPHC is the recognized center of excellence for risk communication, providing worldwide risk communication support for over 20 years. We are uniquely staffed by risk communicators with backgrounds in chemistry, biology, industrial hygiene, public health and engineering who work side-by-side with other health professionals.

Pest Management/Vector Control Resources

Books

Guide to Venomous and Medically Important Invertebrates, David Bowles, James Swaby and Harold Harlan, 2018

Public Health Entomology, Jerome Goddard, 2012

Control of Communicable Diseases Manual, 18th Edition, David Heymann,(http://www.navybmr.com/study%20material/CCDM.pdf) (NOTE: 20th Edition is available)

Organizations

American Society of Tropical Medicine and Hygiene - American Committee of Medical Entomology: https://www.astmh.org/subgroups/acme

American Mosquito Control Association (https://www.mosquito.org/)

Centers for Disease Control (https://www.cdc.gov/)
- Vector-Borne Disease Regional Centers of Excellence (https://www.cdc.gov/ncezid/dvbd/about/prepare-nation/coe.html)
  - Northeast Regional COE (http://neregionalvectorcenter.com/)
  - Pacific Southwest COE (https://pacvec.us/)
  - Southeastern Regional COE (http://cdcsercoevbd-flgateway.org/)
  - Western Gulf COE (https://www.utmb.edu/wgcvbd)
  - Midwest COE (http://mcevbd.wisc.edu/partners/university-of-wisconsin-madison)
- Division of Vector-borne Diseases (https://www.cdc.gov/ncezid/dvbd/index.html)
- Global Health (https://www.cdc.gov/globalhealth/)

Entomological Society of America (https://www.entsoc.org/)
- Journal of Integrated Pest Management (https://academic.oup.com/jipm)
- Journal of Medical Entomology (https://academic.oup.com/jme)

European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)
- Zoonotic Diseases (https://www.who.int/neglected_diseases/zoonoses/en/)

National Association of City and County Health Organizations (https://www.naccho.org/)

National Center for Medical Intelligence (https://www.ncmi.detrick.army.mil/)

National Pest Management Association (https://npmapestworld.org/)

National Pesticide Information Center (http://npic.orst.edu/)

United States Department of Agriculture (https://www.usda.gov/)

Animal and Plant Health Inspection Service (https://www.aphis.usda.gov/aphis/home/)
Wildlife Services (https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/SA_Program_Overview)
Agricultural Research Service (https://www.ars.usda.gov/)
National Program 104 – Veterinary, Medical and Urban Entomology (https://www.ars.usda.gov/animal-production-and-protection/veterinary-medical-and-urban-entomology/)
Center for Medical, Agricultural, and Veterinary Entomology (https://www.ars.usda.gov/southeast-area/gainesville-fl/center-for-medical-agricultural-and-veterinary-entomology/)
Regional IPM Centers (https://www.ipmcenters.org/)
North Central IPM Center (https://www.ncipmc.org/)
Northeastern IPM Center (https://www.northeastipm.org/index.cfm)
Southern Region IPM Center (https://southernipm.org/)
Western Region IPM Center (http://westernipm.org/)

United States Department of Defense (https://www.defense.gov/)
Armed Forces Pest Management Board (https://www.acq.osd.mil/eie/afpmb/)
Defense Health Agency (https://www.health.mil/About-MHS/OASDHA/Defense-Health-Agency)
Armed Forces Health Surveillance Branch (https://health.mil/Military-Health-Topics/Combat-Support/Armed-Forces-Health-Surveillance-Branch)

Army Public Health Center (https://phc.amedd.army.mil/Pages/default.aspx)
Entomology Products (https://phc.amedd.army.mil/topics/envirohealth/epm/Pages/APHC-Entomology-Products.aspx)
CarePoint (https://carepoint.health.mil/_login/default.aspx?ReturnUrl=%2fsites%2fENTO%2f_layouts%2f15%2fAuthenticate.aspx%3fSource%3d%252Fsites%252FENTO%252FPages%252FAFPMB%255F1532%252Easpx&Source=%2Fsites%2FENTO%2FPages%2FAFPMB%5F1532%2Easpx)
Navy and Marine Corps Public Health Center (https://www.med.navy.mil/sites/nmcphc/Pages/Home.aspx)

United States Environmental Protection Agency (https://www.epa.gov/)
Office of Pesticide Programs (https://www.epa.gov/pesticides)

United States Department of the Interior (https://www.doi.gov/)
National Invasive Species Council (https://www.doi.gov/invasivespecies)

World Health Organization (https://www.who.int/)
Neglected Tropical Diseases (https://www.who.int/neglected_diseases/en/)
Vector Ecology and Management (https://www.who.int/neglected_diseases/vector_ecology/en/)

Tools/Presentations

An Introduction to Insecticides (4th edition): https://ipmworld.umn.edu/ware-intro-insecticides

Armed Forces Pest Management Board Tick Disease Resource Primer (https://extranet.acq.osd.mil/eie/afpmb/cac/ticks/tick_reference/tick_reference.pdf)

The Toxicology and Biochemistry of Insecticides: https://books.google.com/books?id=4023BgAAQBAJ&pg=PR17&lpg=PR17&dq=insect+toxicology+textbook+cornell&source=bl&ots=fXStx_BN-a&sig=ACfU3U39kUj1H6eUg4Z6-eBpWuKtnDOrig&hl=en&sa=X&ved=2ahUKEwiwr6y8-fLqAhXSmXIEHS4LBR44FBDoATAGegQIChAB#v=onepage&q=insect%20toxicology%20textbook%20cornell&f=false

Ethiopia Public Health Training Initiative: Medical Entomology Lecture Notes for Environmental Health Students – https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/env_health_science_students/medicalentomology.pdf

Laboratory Identification of Arthropod Ectoparasites: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3910909/pdf/zcm48.pdf

Louisiana Mosquito Control Training Manual (http://www.lmca.us/Training-Manual-TOC.htm)

Malaria Entomology and Vector Control: Guide for Participants - https://apps.who.int/iris/bitstream/handle/10665/85890/9789241505819_eng.pdf;sequence=1National Pest Management Association Pest Guide: https://www.pestworld.org/pest-guide/

Centers for Disease Control – Illnesses on the rise: Vital Signs (https://www.cdc.gov/vitalsigns/vector-borne/index.html)

World Health Organization – Mosquito-borne Diseases (https://www.who.int/neglected_diseases/vector_ecology/mosquito-borne-diseases/en/)

Mosquito Reviews – Statistics for mosquito-borne diseases and deaths (https://mosquitoreviews.com/learn/disease-death-statistics)

Tick-borne Disease Burden and Trends in the US (Dr, Ben Beard/Division of Vector-borne Diseases, National Center for Emerging and Zoonotic Infectious Diseases): https://extranet.acq.osd.mil/eie/afpmb/cac/ticks/tick_reference/Tick-Borne%20Disease%20Burden%20and%20Trends%20in%20the%20U.S..pdf

Common Urban Pests: Identification, Prevention, and Control (Penn State Cooperative Extension) https://schoolipm.tamu.edu/files/2011/05/Common-urban-pests.pdf

Centers for Disease Control – ArboNet
(https://wwwn.cdc.gov/arbonet/maps/ADB_Diseases_Map/index.html)

Texas A&M AgriLife Extension School Integrated Pest Management Plans -
https://schoolipm.tamu.edu/forms/pest-management-plans/

United States Department of Agriculture, Animal and Plant Health Inspection Service, Identification Technology Program
(https://www.ipmimages.org/browse/nodethumb.cfm?Node=5#)

Centers for Disease Control – Diseases Transmitted by Ticks (US)
(https://www.cdc.gov/ticks/diseases/)

Centers for Disease Control – Disease Transmitted by Ticks (Outside the US)
(https://www.cdc.gov/ticks/diseases/)

National Pesticide Information Retrieval System – Federal Pesticide Products Search
(http://npirspublic.ceris.purdue.edu/ppis/)

Pest/Vector Surveillance and Control Exercises

Establishing, implementing and assessing vector-borne disease response plans/programs is complex and requires an understanding of organizational structure, programmatic responsibilities and entomological expertise. The following two exercises are designed to assess your understanding of policy, roles and responsibilities, and vector biology, surveillance and mitigation methods. Each of the areas below address a piece of a comprehensive, integrated vector management program.

Using your knowledge and experience, describe how you would approach an outbreak of Eastern Equine Encephalitis and plague given the information provide below and found throughout this guide from the perspective of a (1) integrated pest management coordinator responsible for an installation in an disease endemic area and an impacted area, (2) pest management consultant for your Component and (2) uniformed medical entomologist stationed at a regional/area preventive medicine/public health activity.

Eastern Equine Encephalitis 2019

Program Development/Implementation

- Preparation
    - Risk Assessment
        - How?
        - Who?
    - Communication
        - Who? Roles and responsibilities
        - Target audience
            - Who is involved in the surveillance and control program?
            - What is their role?
        - Partners
            - Who are partners outside the DoD?
            - What is their role?
        - Materials
            - What information products are produced?
            - How is information communicated?
            - Who are the recipients?

- Surveillance
    - Epidemiological (lagging indicator)
        - How?
        - Who?
        - Data collection (What? Source?)
    - Environmental (leading indicator)
        - Vectors
        - Pathogen detection
        - Non-human vertebrate hosts
        - Data collection (What? Source?)

    - Other information
        - Meteorological
        - Habitat
    - Output
        - What is the output?
        - Coordination?
        - Risk assessment
            - Inform decision - Response

- Control/Prevention
    - Roles and responsibilities
        - Contractors
        - Installation personnel
    - Program/Response Assessment
        - How
        - When
        - Who
- Program assessment
    - Who is involved?
    - What information is needed?
    - Outcome?

Background:

-EEE is a rare disease that is caused by a virus spread by infected mosquitoes. EEE virus (EEEV) is one of a group of mosquito-transmitted viruses that can cause inflammation of the brain (encephalitis). In the United States, approximately 5-10 EEE cases are reported annually.

-Most cases of EEE have been reported from Atlantic and Gulf Coast states. Cases have also been reported from the Great Lakes region. EEE cases occur primarily from late spring through early fall, but in subtropical endemic areas (e.g., the Gulf States), rare cases can occur in winter

-Historically, EEE outbreaks have rarely occurred during periods lasting more than three years, but the pattern may be changing

-Primary vectors (site dependent): *Aedes albopictus,* Ae. vexans, *Coquillettidia perturbans, Culex nigripalpus*, *Cx. Salinarius, Culiseta melanura*, *Ochlerotatus canadensis*, and *Oc. sollicitans*

-Outbreaks maybe supported by:

- Previously unexposed bird populations that are susceptible to EEE capable of maintaining the cycle of virus transmission
- Introduction of a new strain of EEE virus by migratory birds
- Large *Culiseta melanura* populations

- Weather conditions (significant precipitation events, prolonged periods of high temperatures, moderate winters (northern distribution))
- Human population location/exposure

-"Outbreaks" in Northeast/Midwest US normally occur every 5-6 years and last 2-3 years

-2019 Timeline (Northeast/Midwest/South/Mid-south)

- June 30, 2019: First positive EEE mosquito pool reported from Monmouth County, New Jersey

- July 09-13, 2019: First positive EEE mosquito pool reported from Ocean County, New Jersey – JB MLD location

- July 31, 2019 – First EEE positive mosquito pool reported from Connecticut (Voluntown)

- August 2019: Human Case reported from Tennessee

- August 2019: First EEE positive mosquito pools reported from Michigan

- Mid-August 2019: First EEE positive mosquito pools reported from northern Indiana

- August 6, 2019: First EEE positive mosquito pools reported from Rhode Island (Central Falls)

- August 10, 2019: Human Case reported from Massachusetts

- August 13, 2019: First EEE positive mosquito pools reported from New Hampshire (Town of Pelham)

- August 18, 2019: First EEE positive mosquito pools reported from 3 northern New Jersey counties (Morris, Sussex and Warren). First time in since 2011

- September 8, 2019: Human Case reported from Rhode Island

- September 19, 2019: Human Case reported from Connecticut (State of Connecticut mosquito trapping – pathogen testing on NSB Groton/New London

- September 19, 2019: Positive EEE mosquito pool JB MDL, NJ/Information passed on JB MDL Facebook page

- September 19, 2019: Army Public Health Center posts information concerning EEE on website

(https://phc.amedd.army.mil/PHCResourceLibrary/EasternEquineEncephalitis_FS_18-020-0919.pdf)

- September 23, 2019: "Mosquito found at Joint Base tests positive for dangerous disease" – WHYY.com (https://whyy.org/articles/mosquito-found-at-joint-base-tests-positive-for-dangerous-disease/)

- September 27, 2019: "Army public health officials give tips on preventing Eastern equine encephalitis" – Army.mil (https://www.army.mil/article/227745/army_public_health_officials_give_tips_on_preventing_eastern_equine_encephalitis)

- September 20, 2019: Human cases reported from Michigan and New Jersey

- October 9, 2019: Human case reported from North Carolina

- October 14, 2019: Human case reported from northern Indiana

National and State Vector-borne Disease Information:

-National summary 2019 (https://www.cdc.gov/easternequineencephalitis/tech/epi.html)

- As of December 3, 2019, CDC has received reports of 37 confirmed cases of Eastern equine encephalitis for this year including 15 deaths. Cases have been reported from the following eight states: Alabama (1), Connecticut (4), Indiana (1), Massachusetts (12), Michigan (10), North Carolina (1), New Jersey (4), Rhode Island (3) and Tennessee (1).

State	Number of reported human cases 2009-2018	Number of reported human cases 2019
Alabama	1	1
Arkansas	1	0
Connecticut	1	4
Florida	13	0
Georgia	6	0
Indiana	0	1
Louisiana	2	0
Maine	2	0
Maryland	1	0
Massachusetts	10	12
Michigan	7	10
Missouri	1	0
Montana	1	0
New Hampshire	3	0
New Jersey	1	4
New York	8	0
North Carolina	7	1

Pennsylvania	1	0
Rhode Island	1	3
Tennessee	0	1
Vermont	2	0
Virginia	1	0
Wisconsin	2	0
Total	72	37

CDC ArboNET (19NOV19): 2019 EEE distribution (Human, Mosquito, Bird, Sentinel Animal, Veterinary) (https://wwwn.cdc.gov/arbonet/maps/ADB_Diseases_Map/index.html)

State Summaries

-Alabama (http://www.alabamapublichealth.gov/mosquito/index.html):

- 2018 summary: 0 human cases. Mosquito collection occurs throughout the state. No information is publically available

- 2019 summary: 1 human case. No mosquito information available

-Connecticut (https://portal.ct.gov/mosquito):

- 2018 summary: 0 human cases. Mosquito collection occurs throughout the state, including on NSB New London (1,928 mosquitoes/0 positive pools). Total: 315,216 mosquitoes tested, 6 EEE positive pools.

- 2019 summary: 4 human cases. 239,960 mosquitoes tested, 122 EEE positive pools (NSB New London – 2,608 mosquitoes tested (*Cs. melanura*)/3 EEE positive pools)

-Indiana (https://www.in.gov/isdh/28258.htm):

- 2018 summary: 0 human cases. No mosquito surveillance information available

- 2019 summary: 1 human case. No mosquito surveillance information available

-Massachusetts https://www.mass.gov/mosquito-borne-diseases):

- 2018 summary: No confirmed human EEE cases in 2018 or 2017, compared to seven confirmed human cases in 2012 and one in 2013. 2012 was the most recent outbreak year in Massachusetts. There was a similar decline in EEE virus positive mosquito samples from 267 in 2012 to two in 2018. In general, years with increased EEE human infections are associated with an increase in the percentage of *Cs. melanura* sample positive for EEE virus.

- Projection 2019: The summer and fall of 2018 brought above average temperatures ad precipitation events leading to extensive breeding habitat for

the traditional vectors of EEE. A preliminary assessment of the winter of 2018-1019 has average temperatures combined with above average precipitation. Early reports from the field indicate above average numbers of juvenile *Cs. melanura*. Less is known about the factors leading to large numbers of infected birds.

- 2019 summary: 12 human and 9 animal cases reported. Mosquito collection occurs throughout the state 428 positive mosquito pools

-Michigan (https://www.michigan.gov/emergingdiseases/0,4579,7-186-76711_77442---,00.html):

- 2018 summary: 1 human case, 2 other mammals, 0 mosquito pools/not tested for EEE

- 2019 summary: 10 human cases, 48 animal cases, 0 mosquito pools/not tested for EEE

-New Jersey (https://nj.gov/health/cd/statistics/arboviral-stats/index.shtml):

- 2018 summary: 0 human cases. 2,603 pools tested (14 positive pools)

- 2019 summary: 4 human cases. 10,581 pools tested (73 positive pools)

-North Carolina (https://epi.dph.ncdhhs.gov/cd/diseases/vector.html):

- 2018 summary: 0 human cases. Mosquito information not available

- 2019 summary: 1 human case. Mosquito information not available

-Rhode Island (http://www.health.ri.gov/data/arboviralsurveillance/):

- 2018 summary: 0 human cases. Mosquito information not available

- 2019 summary: 3 human cases. 4 animal cases. 2,453 mosquito pools tested (9 positive)

-Tennessee (https://www.tn.gov/health/cedep/reportable-diseases/equine-encephalitis-viruses.html):

- 2018 summary: 0 human cases. Mosquito information not available

- 2019 summary: 1 human case. Mosquito information not available

DoD/Guard/Reserve Installations Impacted

Northeast

Connecticut
NSB New London/Groton
Stones Ranch Military Reserve
Bradley International Airport

New Jersey
Picatinny Arsenal
NWS Earle
McGuire AFB
JB MLD
Warren Grove Range
Atlantic City International Airport

Massachusetts
Devens Reserve Forces Training Area
Hanscom AFB
Westover AFB
Barned Air National Guard Base
Cape Cod AFS
Camp Edwards
Otis Air National Guard Base

Rhode Island
NS Newport
NG camp Fogarty
Quonset State Airport

Midwest

Indiana
Fort Wayne International Airport
Grissom Air reserve Base
Hulman Regional Airport
Camp Attebury
Jefferson Proving Ground
NSA Crane
Indiana Army Ammunition Plant

Michigan
Military Training Center Camp Grayling
Alpena County Regional Airport
Selfridge Air National Guard Base
Detroit Arsenal
WK Kellogg Airport
Fort Custer Training Center

South/Mid-south

North Carolina
Dare County Range
Seymour Johnson Air Force Base
MCAS Cherry Point
MCB Camp Lejeune
Pope AFB
Fort Bragg
Camp Mackall
Charlotte/Douglas International Airport
Military Ocean Terminal Sunny Point

Tennessee
NSA Mid-South Millington/Memphis
Milan Army Ammunition Plant
Nashville International Airport
Volunteer Army Ammunition Plant
Holston Army Ammunition Plant
Memphis International Airport

Federal Government Agencies and Organizations

Department of Health and Human Services (HHS)
Centers for Disease Control and Prevention (CDC)

Department of Agriculture (USDA)
Animal and Plant Health Inspection Service (APHIS)

Department of the Interior (DoI)
United States Geological Survey (USGS)

Department of Defense: Installations/Pest Management
OSD
Defense Logistics Agency
Army
Installation Management Command (IMCOM)

Navy
Naval Facilities Engineering Command Atlantic (NAVFAC Atlantic)

Air Force
Air Force Civil Engineer Center (COSC)

Department of Defense: Public Health
OSD
Defense Health Agency
Veterinary Services
Armed Forces Health Surveillance Branch
Army
Army Public Health Center
Army Public Health Command – Atlantic

Navy
Navy and Marine Corps Public Health Center
Environmental and Preventive Medicine Unit -2
Navy Entomology Center of Excellence

Air Force
United States Air Force School of Aerospace Medicine (USAFSAM)

State Government Agencies and Organizations

Installations: National Guard
Army National Guard
Air Force National Guard

Public Health
Connecticut
Connecticut Department of Public Health - Epidemiology and Emerging Infections Program

Connecticut Agricultural Experiment Station - Mosquito Trapping and Arbovirus Testing Program

Indiana

Indiana Department of Health - Epidemiology Resource Center/Zoonotic and Vector-borne Disease

Massachusetts

Massachusetts Department of Public Health - Bureau of Infectious Disease Laboratory Sciences

Michigan

Michigan Department of Health and Human Services - Emerging Diseases

New Jersey

New Jersey Department of Health - Communicable Disease Service

North Carolina

North Carolina Department of Health and Human Services - Epidemiology

Rhode Island

Rhode Island Department of Health – Center for Biological Sciences

Tennessee

Tennessee Department of Health

Mosquito/Vector Control Resources

Connecticut

Connecticut Mosquito Management Program - Department of Energy and Environmental Protection
Connecticut Mosquito Management Program - Connecticut Agricultural Experiment Station
Connecticut Mosquito Management Program - Department of Public Health

Indiana

Various – Based on county capabilities

Massachusetts

Bristol County Mosquito Control Project
Cape Cod Mosquito Control Project
Central Massachusetts Mosquito Control Project
Dukes County Mosquito Control Project
East Middlesex Mosquito Control Project
Norfolk County Mosquito Control District
Northeast Massachusetts Mosquito and Wetlands Management District
Pioneer Valley Mosquito Control Project
Plymouth County Mosquito Control Project

Suffolk County Mosquito Control Project

Michigan
Bay County Mosquito Control
Midland County Mosquito Control
Saginaw County Mosquito Abatement Commission
Tuscola County Mosquito Abatement

New Jersey
Atlantic County Office of Mosquito Control
Bergen County Division of Mosquito Control
Burlington County Division of Mosquito Control
Camden County Mosquito Extermination Commission
Cape May County Department of Mosquito Control
Cumberland County Mosquito Control Division
Essex County Division of Environmental Affairs
Gloucester County Public Works Division of Mosquito Control
Hudson County Mosquito and Vector Control Unit
Hunterdon County Division of Public Health Services
Mercer County Mosquito Control
Monmouth County Mosquito Control Division
Morris County Division of Mosquito Control
Ocean County Mosquito Extermination Commission
Passaic County Department of Health Division of Mosquito Control
Salem County Mosquito Control
Somerset County Mosquito Control
Sussex County Office of Mosquito Control
Union County Bureau of Mosquito Control
Warren County Mosquito Extermination Commission

North Carolina
Various – Based on county capabilities

Rhode Island
State mosquito surveillance and control program – Department of Health and Department of Environmental Management

Tennessee
Various – Based on county capabilities

Plague

Program Development/Implementation

- Preparation
  - Risk Assessment
    - How?
    - Who?
  - Communication
    - Who? Roles and responsibilities
    - Target audience
      - Who is involved in the surveillance and control program?
      - What is their role?
    - Partners
      - Who are partners outside the DoD?
      - What is their role?
    - Materials
      - What information products are produced?
      - How is information communicated?
      - Who are the recipients?

- Surveillance
  - Epidemiological (lagging indicator)
    - How?
    - Who?
    - Data collection (What? Source?)
  - Environmental (leading indicator)
    - Vectors
    - Pathogen detection
    - Non-human vertebrate hosts
    - Data collection (What? Source?)
  - Other information
    - Meteorological
    - Habitat
  - Output
    - What is the output?
    - Coordination?
    - Risk assessment
      - Inform decisions - Response

- Control/Prevention
  - Roles and responsibilities
    - Contractors
    - Installation personnel
  - Program/Response Assessment
    - How
    - When

        - Who
- Program assessment
    - Who is involved?
    - What information is needed?
    - Outcome?

Background: The bacteria that cause plague, *Yersinia pestis*, maintain their existence in a cycle involving rodents and their fleas. Plague occurs in rural and semi-rural areas of the western United States, primarily in semi-arid upland forests and grasslands where many types of rodent species can be involved. Many types of animals, such as rock squirrels, wood rats, ground squirrels, prairie dogs, chipmunks, mice, voles, and rabbits can be affected by plague. Wild carnivores can become infected by eating other infected animals.

Humans are usually more at risk during, or shortly after, a plague epizootic. Scientific studies have suggested that epizootics in the southwestern United States are more likely during cooler summers that follow wet winters. Epizootics are most likely in areas with multiple types of rodents living in high densities and in diverse habitats.

In parts of the developing world, plague can sometimes occur in urban areas with dense rat infestations.

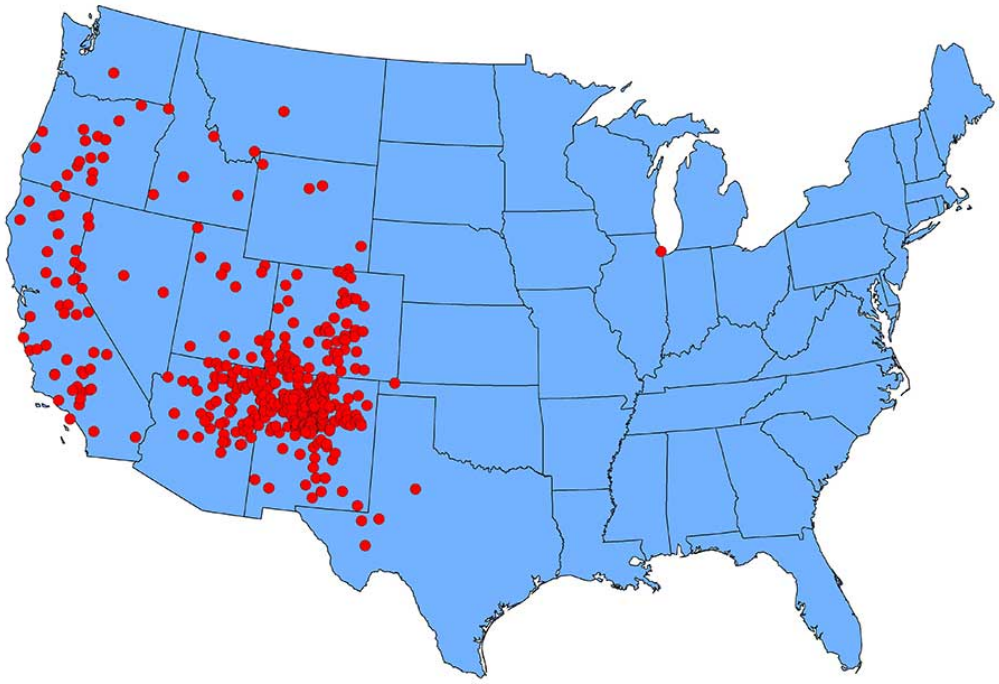
Transmission: The plague bacteria can be transmitted to humans in the following ways:

> Flea bites. Plague bacteria are most often transmitted by the bite of an infected flea. During plague epizootics, many rodents die, causing hungry fleas to seek other sources of blood. People and animals that visit places where rodents have recently died from plague are at risk of being infected from flea bites. Dogs and cats may also bring plague-infected fleas into the home. Flea bite exposure may result in primary bubonic plague or septicemic plague.
>
> Contact with contaminated fluid or tissue. Humans can become infected when handling tissue or body fluids of a plague-infected animal. For example, a hunter skinning a rabbit or other infected animal without using proper precautions could become infected with plague bacteria. This form of exposure most commonly results in bubonic plague or septicemic plague.
>
> Infectious droplets. When a person has plague pneumonia, they may cough droplets containing the plague bacteria into air. If these bacteria-containing droplets are breathed in by another person they can cause pneumonic plague. Typically this requires direct and close contact with the person with pneumonic plague. Transmission of these droplets is the only way that plague can spread between people. This type of spread has not been documented in the United States since 1924, but still occurs with some frequency in developing countries. Cats are particularly susceptible to plague, and can be infected by eating infected rodents. Sick cats pose a risk of transmitting infectious plague droplets to

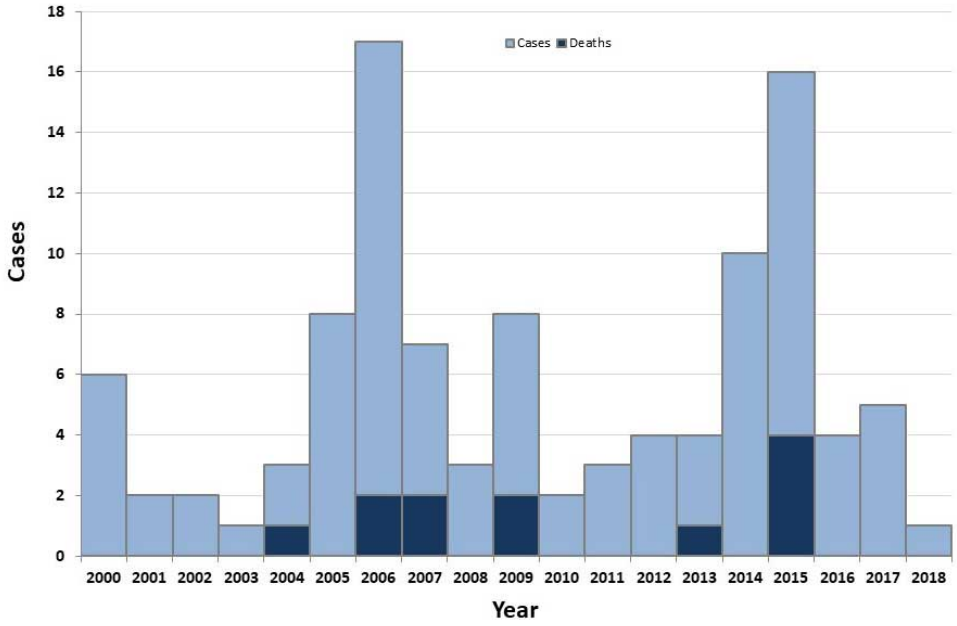
their owners or to veterinarians. Several cases of human plague have occurred in the United States in recent decades as a result of contact with infected cats.

Ecology: https://www.cdc.gov/plague/resources/PlagueEcologyUS.pdf

Distribution - Western and southwestern United States 1970-2018 (CDC - https://www.cdc.gov/plague/maps/index.html)



Human Plague Cases and Deaths – United States 2000-2018



State Departments of Health

Arizona Department of Health Services

- Epidemiology and Disease Control Statistics (https://www.azdhs.gov/preparedness/epidemiology-disease-control/index.php#data-stats-past-years)
- Vector-borne and zoonotic diseases (https://www.azdhs.gov/preparedness/epidemiology-disease-control/vector-borne-zoonotic-diseases/index.php)

California Department of Public Health (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Plague.aspx)

- Rodent and plague surveillance (https://www.arcgis.com/apps/ImpactSummary/index.html?appid=6627dfd8b7f1485cbdfda824965e49b3)
- Vector-borne disease section annual reports (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/VBDSAnnualReports.aspx)
- Vector-borne disease section (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/VBDS.aspx)

Colorado Department of Public Health and Environment (https://www.colorado.gov/pacific/cdphe/plague)

- Animal: 2017 (https://docs.google.com/document/d/1xYoGIRPnZVrLIBujJ1y8fi_P6zA5lEIkTiZ1rboxeFs/pub)
- Animal: 2016 (https://docs.google.com/document/d/1R0sstW2bhUft-gPUerIhHxiBMuPufqDQ30mC77RFxI0/pub)

- Human: 2005-2017 (https://docs.google.com/document/d/1E-iG_nC2GCLJW-twhL_5QPjNGr7spny_WhzbeFGacIs/pub)

Idaho Department of Health and Welfare (https://healthandwelfare.idaho.gov/Home/tabid/55/Default.aspx)

- Reportable Disease Summaries (https://healthandwelfare.idaho.gov/Health/Epidemiology/IdahoDiseaseSummary/tabid/202/Default.aspx)

New Mexico Department of Health (https://www.nmhealth.org/about/erd/ideb/zdp/plg/)

- Animal
    - There have been no animal plague cases in 2020.
    - There have been two Animal Plague Cases in New Mexico in 2019 in one dog in Quay County and one cat in Santa Fe County.
    - There have been three Animal Plague Cases in New Mexico in 2018 in two dogs from Santa Fe County and one dog from Torrance County.
    - There were 28 Animal Plague Cases in New Mexico in 2017 in 11 dogs and two cats from Santa Fe County, three dogs, three cats, a mouse, and a wood rat from Bernalillo County, two dogs from Los Alamos County, a dog from Sandoval County, a cat from Rio Arriba County, a cat and a dog from Taos County, and a dog from Torrance County.
    - There were 34 confirmed Animal Plague Cases in New Mexico in 2016 in two rabbits, a bear, and a dog from Sandoval County, eleven dogs and two cats from Santa Fe County, a dog and a cat from Torrance County, three cats and three dogs from Bernalillo County, a dog and a cat from Los Alamos County, three cats and a dog from Taos County, and two dogs and a cat from Rio Arriba County
- Human
    - By month, year, decade – 1949-2019 (https://www.nmhealth.org/data/view/infectious/1012/)
    - By county - 1949-2019 (https://www.nmhealth.org/data/view/infectious/1013/)

Nevada Department of Health and Human Services (http://dpbh.nv.gov/)

Oregon Health Authority (https://www.oregon.gov/oha/PH/DISEASESCONDITIONS/DISEASESAZ/Pages/plague.aspx)

- Human plague cases 1934-2015 (https://www.oregon.gov/oha/PH/DISEASESCONDITIONS/DISEASESAZ/Plague1/plaguemap.pdf)

Texas Department of Health and Human Services (https://hhs.texas.gov/)

- Plague (https://www.dshs.state.tx.us/IDCU/disease/plague/Description.aspx)
- Data and reports (https://www.dshs.state.tx.us/idcu/health/zoonosis/disease/Cases/)

Utah Department of Health (http://health.utah.gov/epi/diseases/plague/)

- Data and reports (http://health.utah.gov/epi/data/)

Wyoming Department of Health (https://health.wyo.gov/)

- Disease information (https://health.wyo.gov/publichealth/infectious-disease-epidemiology-unit/disease/plague/)

DoD Installations and Locations

Arizona:
Davis-Monthan AFB
Fort Huachuca
Luke AFB
Marine Corps Air Station Yuma
National Guard Camp Navajo
National Guard Florence Military Reservation
Yuma Proving Ground

California:
Beale Air Force Base
Defense Distribution Region West – Tracy
Edwards Air Force Base
Fort Hunter Liggett
Fort Irwin
Los Angeles Air Force Base
March Air Reserve Base
Marine Corps Air Station Miramar
Marine Corps Air Ground Combat Center Twentynine Palms
Marine Corps Base Camp Pendleton
Marine Corps Logistics Base
Marine Corps Recruiting Depot
Marine Cold Weather Training Center Bridgeport
Naval Air Field El Centro
Naval Air Station Lemoore
Naval Air Station North Island
Naval Air Weapons Station China Lake
Naval Base Ventura City Point Mugu
Naval Medical Center San Diego
Naval Station San Diego
Naval Submarine Base San Diego
Naval Support Detachment Monterey
Naval Weapons Station Seal Beach
Presidio of Monterey
San Clemente Island
Sierra Army Depot
Travis Air Force Base

Vandenberg Air Force Base

Colorado:
Buckley Air Force Base
Fort Carson
Peterson Air Force Base
Pinon Canyon Maneuver Site
Pueblo Chemical Depot
Rocky Mountain Arsenal
Schriever Air Force Base
United States Air Force Academy

Idaho:
Juniper Butte Range
Mountain Home Air Force Base
National Guard Gowen Field Boise
Saylor Creek Air Force Range

New Mexico:
Kirtland Air Force Base
Cannon Air Force Base
White Sands Missile Range
Holloman Air Force Base

Nevada:
Creech Air Force Base
Hawthorne Army Depot
Naval Air Station Fallon
Nellis Air Force Base

Oregon:
Air National Guard Klamath Falls Airport-Kingsley Field
National Guard Biak Training Center

Texas:
Camp Bullis
Camp Maxey
Camp Swift
Dyess Air Force Base
Fort Bliss
Fort Hood
Fort Sam Houston
Fort Wolters
Goodfellow Air Force Base
Lackland Air Force Base
Laughlin Air Force Base

Naval Air Station Corpus Christi
Naval Air Station/Joint Reserve Base Fort Worth
Naval Air Station Kingsville
Red River Army Depot
Sheppard Air Force Base

Utah:
Dugway Proving Ground
Green River Test Complex
Hill Air Force Base
Tooele Army Depot

Wyoming:
F. E. Warren Air Force Base