CDPH
California Department of
PublicHealth

BEST MANAGEMENT PRACTICES

FOR MOSQUITO CONTROL ON CALIFORNIA STATE PROPERTIES

TO DOWNLOAD AN ELECTRONIC VERSION, VISIT THE CALIFORNIA DEPARTMENT OF PUBLIC HEALTH WEBSITE AT HTTP://WWW.CDPH.CA.GOV (SEE PROGRAMS/VECTOR-BORNE DISEASE SECTION).

For more information, please contact:

Vector-Borne Disease Section

California Department of Public Health

(916) 552-9730

http://www.cdph.ca.gov

http://westnile.ca.gov

BEST MANAGEMENT PRACTICES

FOR MOSQUITO CONTROL ON CALIFORNIA STATE PROPERTIES

RECOMMENDATIONS OF THE
CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
JUNE 2008

ARNOLD SCHWARZENEGGER
GOVERNOR
STATE OF CALIFORNIA

KIMBERLY BELSHÉ
SECRETARY
CALIFORNIA HEALTH AND
HUMAN SERVICES AGENCY

MARK B HORTON, MD, MSPH
DIRECTOR
CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

ACKNOWLEDGEMENTS

EDITOR IN CHIEF

Carrie Nielsen, PhD, California Department of Public Health (CDPH)

COMMITTEE CHAIR

Vicki Kramer, PhD, CDPH

STEERING COMMITTEE MEMBERS

California Department of Fish and Game (DFG)
Dean Kwasny

California Department of Food and Agriculture (CDFA)
Duane Schnabel

California Department of General Services (DGS)
Phil Henderson; Joe Mugartegui; Joe White

California Department of Pesticide Regulation (DPR)
Patricia Matteson, PhD

California Department of Public Health (CDPH)
Claudia Erickson, MS; Tim Howard, MS; Renjie Hu, PhD; Stan Husted, MPH; Jonathan Kwan, MS; Marco Metzger, PhD; Mark Novak, PhD

California Department of Transportation (Caltrans)
Karl Dreher, PE; Sheree Edwards; Bala Nanjundaiah

California State Parks (CSP)
Stephen Bakken

Mosquito and Vector Control Association of California (MVCAC)
David Brown, Sacramento-Yolo Mosquito and Vector Control District;
Steve West, Kenn Fujioka, PhD, San Gabriel Valley Mosquito and Vector Control District;
John Stroh, San Joaquin Mosquito and Vector Control District

University of California, Davis (UCD), Center for Vectorborne Diseases (CVEC)
William Reisen, PhD

University of California, Riverside (UCR)
William Walton, PhD

It is the responsibility of all agencies to protect public health by controlling mosquitoes on their property. Please refer to the section of this plan that pertains to your agency or property type and review the background information on mosquitoes and mosquito management.

Use this plan to identify and implement appropriate Best Management Practices (BMPs) to control mosquitoes.

Eliminate unnecessary standing water, reduce stagnation by providing water flow, and manage vegetation in ponds or other water bodies.

Collaborate with local vector control agencies to develop and implement appropriate integrated pest management (IPM) strategies that are most suitable for specific land-use type(s).

Ensure employees use personal protective measures when potentially exposed to adult mosquitoes.

TABLE OF CONTENTS

EXECUTIVE SUMMARY AND RECOMMENDATIONS

The California Department of Public Health (CDPH), in collaboration with Steering Committee members, developed this Best Management Practices (BMPs) plan to enhance early detection of West Nile virus (WNV) and promote mosquito control on state-owned properties in response to the Governor's Emergency Proclamation on August 2, 2007 (Appendix A). Order number 3 states:

> **IT IS FURTHER ORDERED** that the Department of Public Health shall coordinate with the State and Consumer Services Agency, the Resources Agency and the Department of Food and Agriculture to develop a plan using best management practices for implementation by the appropriate state agencies for the early detection of West Nile virus on state-owned properties and appropriate mitigation and abatement measures.

This plan describes mosquito control BMPs to be implemented by the appropriate state agency. These recommended practices, when properly implemented, can reduce mosquito populations through a variety of means including: 1) reducing or eliminating breeding sites, 2) increasing the efficacy of biological control, and 3) increasing the efficacy of chemical control measures. It is critical that state agencies communicate regularly with local vector control agencies regarding control practices on state-owned properties that are located within or near a local agency's jurisdiction. Local vector control agencies may have more specific policies regarding the implementation of BMPs and other control operations on state lands, which may include use of enforcement powers authorized by the California Health and Safety Code.

This BMP plan for mosquito control on state-owned properties reflects input from the BMP steering committee members, and suggestions and comments from many additional stakeholders and representatives of state agencies that manage state-owned properties. There are many different BMPs included in this document and they are intended to provide overall guidance to reduce mosquito production on state-owned properties throughout California, though not all mosquito sources and land uses will be addressed in this document. If it is deemed necessary, site-specific BMP plans may be developed in collaboration with CDPH and the respective local mosquito and vector control agency.

Effective mosquito-borne disease surveillance and mosquito control to protect public health are dependent upon factors that may fluctuate temporally and regionally. Such factors include mosquito and pathogen biology, environmental factors, land-use patterns, resource availability, available mosquito control services, and institutional and legal constraints. Management strategies that incorporate BMPs are the most effective means by which mosquito control can be conducted and individualized to specific situations. Best management practices included in this plan emphasize the fundamentals of integrated pest management (IPM), which include:

1. Knowledge of mosquito species composition and corresponding mosquito behavior and habitat, for both immature and adult stages.
2. Detecting and monitoring WNV activity by testing mosquitoes, birds, sentinel chickens, horses, and humans. Identifying the mosquito species present, locations, densities, and disease potential.
3. Managing mosquito populations by source reduction, habitat modification, and biological control (e.g., introduced predators and parasites). Pesticides are used to target immature and, when indicated, adult stages of the mosquito. Mosquito control products are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.
4. Educating the general population about reducing mosquito production and minimizing their risk of exposure to WNV.

RECOMMENDATIONS FOR MANAGERS OF STATE-OWNED PROPERTIES

- Use this plan to identify and implement appropriate Best Management Practices (BMPs) to control mosquitoes.
- Eliminate unnecessary standing water, reduce stagnation by providing water flow, and manage vegetation in ponds or other water bodies.
- Collaborate with local vector control agencies to develop and implement appropriate integrated pest management (IPM) strategies that are most suitable for specific land-use type(s).
- Ensure employees use personal protective measures when potentially exposed to adult mosquitoes.

INTRODUCTION

On August 2, 2007, the Governor of California issued a Proclamation of Emergency in response to rapidly escalating West Nile virus (WNV) activity and the commensurate threat to public health (Appendix A). Under the Emergency Proclamation the California Department of Public Health (CDPH), in coordination with the State and Consumer Services Agency, the Resources Agency and the Department of Food and Agriculture, developed this plan to be implemented by state agencies to enhance early detection and control of WNV on state-owned properties using Best Management Practices (BMPs).

BMPs describe land management practices intended to reduce mosquito populations by eliminating standing water, modifying habitat, enhancing natural predation on mosquito larvae, and using highly specific mosquito control products. BMPs are a fundamental attribute of an Integrated Pest Management (IPM) program, which combines chemical and non-chemical control measures to reduce populations of mosquitoes while minimizing the potential impacts to people, other organisms, and the environment. Most mosquito control programs in California adhere to IPM principles. Raising both community and land managers' awareness of mosquitoes and mosquito-borne diseases may increase the effectiveness of an IPM program. Also emphasized in IPM programs is the need to raise community awareness about the importance of using personal protective measures to reduce the risk of disease transmission.

The recommended BMPs in this plan should be implemented by the appropriate state agency, in conjunction with local mosquito control programs, to reduce mosquito production on state-owned properties throughout California. The various land use categories of state-owned properties in this plan include: 1) buildings and grounds, 2) managed and natural wetlands, 3) stormwater devices, 4) transportation infrastructure, 5) state parks, and 6) conservancies. CDPH provides consultation for selecting the best means for reducing mosquito production and can assist in coordinating activities with local vector control agencies. This assistance by CDPH may be especially necessary for state agencies that manage lands that are not within the jurisdiction of an established mosquito control program. Appendix B provides a summary of state-owned properties and management agencies.

WEST NILE VIRUS AND MOSQUITO CONTROL IN CALIFORNIA: AN OVERVIEW

WNV is a potentially serious illness. The vast majority of human infections (approximately 80%) go unnoticed due to mild or nonexistent symptoms; however approximately 20% of infected individuals will develop West Nile fever. Symptoms of West Nile fever may include fever, head and body aches, nausea, vomiting, swollen lymph glands, and skin rash on the chest, stomach, and back. Within this group, about one in 150 people will develop a more serious form of illness with symptoms such as high fever, headache, neck stiffness, stupor,

disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness, and paralysis. This severe form of infection with WNV may result in long-lasting, debilitating physical disorders and can be fatal in certain people, particularly the elderly.

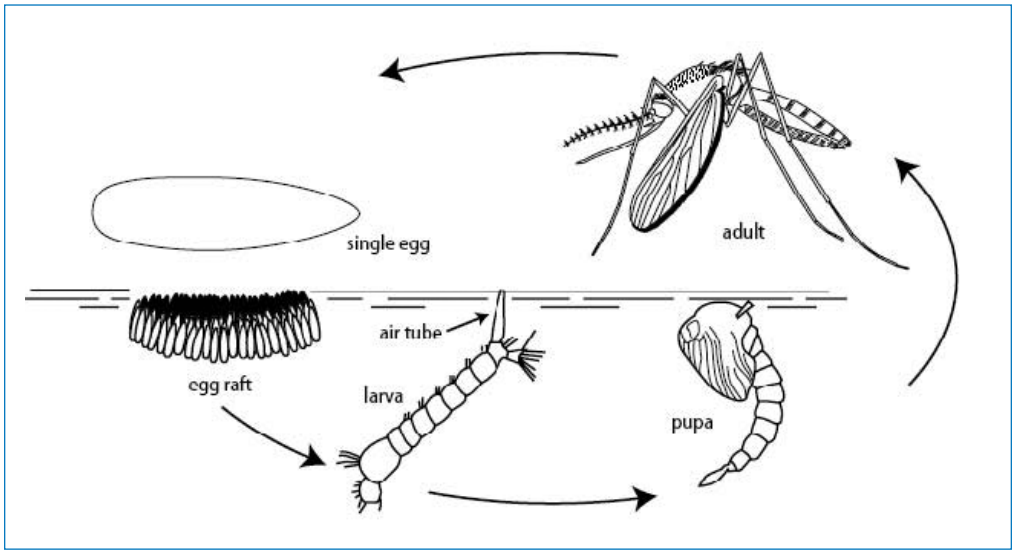
WNV is an avian pathogen that is maintained in nature in a bird-mosquito-bird transmission cycle. Occasionally, the virus is carried outside this natural cycle and causes disease in humans and other animals. The primary agents (i.e. vectors) responsible for spreading the virus between animals are mosquitoes. Female mosquitoes become infected with virus after taking a blood meal from a bird with high "viremia" defined as the presence of large quantities of virus in the blood. The virus replicates quickly over a period of days and spreads throughout the body of the mosquito. These infected mosquitoes inject contaminated saliva into the skin of animals each time they attempt to take more blood.

CDPH, local health departments, and mosquito and vector control agencies have the important responsibility of protecting the public from mosquito-borne diseases. These agencies work collaboratively to minimize the risk of mosquito-borne disease transmission through comprehensive mosquito surveillance and control efforts, by providing technical guidance and information to the medical and veterinary communities, and by educating the public about mosquitoes, the diseases they carry, and personal protective measures.

California has a long history of mosquito-borne disease occurrence, including outbreaks of malaria, western equine encephalomyelitis (WEE), and St. Louis encephalitis (SLE). Mosquito control programs were first developed in the early 1900s to combat these diseases and reduce populations of nuisance mosquitoes. Today there are more than 70 local agencies throughout California that provide mosquito and vector control services. Together, these agencies serve more than 85% of California's residents over an area of approximately 60,000 square miles, representing one of the most comprehensive public health programs in the world.

A mosquito-borne disease surveillance program has been ongoing in California since 1969. To prepare for the introduction of WNV into California, CDPH, in conjunction with state and local partners, modified and expanded the program in 2000. The newly developed surveillance and response plan for WNV in California includes procedures to monitor for and reduce the risk of disease due to WNV. In 2003, WNV was detected for the first time in southern California, and by 2004 WNV was detected in all 58 California counties. Through 2007, a total of 2,318 human WNV cases were reported of which 55 were fatal. Up-to-date information on WNV in California can be found on the CDPH WNV website: http://westnile.ca.gov.

GENERAL BIOLOGY OF CALIFORNIA MOSQUITOES



THE LIFE CYCLE OF ALL MOSQUITO SPECIES CONSISTS OF FOUR STAGES: EGG, LARVA, PUPA AND ADULT. FIGURE FROM: WWW.UCMRP.UCDAVIS.EDU/

MOSQUITO LIFE CYCLE

Mosquitoes are found throughout most of California and can be a public health and veterinary health threat. Female mosquitoes take a blood meal by inserting their needle-like mouthparts into the skin, injecting saliva, and drawing out blood. Mosquito bites frequently cause skin irritation in humans. Thus in the absence of disease, mosquitoes can also be a significant nuisance. Each mosquito species has a Latin or Greek-based scientific name and the more well-known species also have common names that describe their habits, biology, or appearance (e.g., pasture mosquito, tree-hole mosquito).

The life cycle of a mosquito consists of four stages: egg, larva, pupa, and adult. The immature stages are completed in standing water. Depending on species, females will lay their eggs either singly or in clusters. Some species will deposit their eggs on the surface of calm water, whereas others deposit their eggs on land in areas subject to flooding. Free-swimming larvae hatch in water and feed on organic matter and microorganisms such as bacteria. During growth, the larva molts (casts its skin) four times; the stages between successive molts are known as instars. The pupa is a non-feeding stage of several days duration, undergoing morphological and physiological changes required to transform from larva to adult. Seasonal and environmental conditions determine the length of time it takes for larval mosquitoes to complete their development; some species develop faster than others under the same conditions. Depending on average temperatures, it may take from four days to a month for the mosquito to mature from egg to adult; with warmer temperatures development accelerates. Only female mosquitoes require meals of blood and most live for about two weeks, although some

may survive two to three months. Adult females that emerge late in the season may hibernate through the winter to begin laying eggs in the spring. Adult male mosquitoes feed on nectar or plant juices and are very short lived by comparison.

Over 160 mosquito species in 13 genera are found in North America. California encompasses a diverse range of habitats and ecology; at least 52 species of mosquitoes are known to occur. The majority of these species fall within four major groups or genera: *Aedes*, *Anopheles*, *Culiseta*, and *Culex*. Please see Appendix D for more information on the biology of these genera and key mosquito species.

MOSQUITOES AS DISEASE VECTORS

Mosquitoes are the most important insect vectors of disease worldwide, causing millions of human deaths every year. Mosquito-borne pathogens are transmitted when a female mosquito pierces the skin of an animal to feed on blood; however, not all mosquito species are 'competent' vectors (i.e., capable of becoming infected, replicating the virus, and transmitting the virus); however, each species' capacity as a vector varies.

Of 12 mosquito-borne viruses currently recognized in California, only WNV, WEE, and SLE are significant threats to public health. However, increasing global trade and travel provides an avenue for introducing and/or re-introducing other mosquito-borne pathogens and their vectors into California and the United States. The diseases of greatest concern include Japanese encephalitis, dengue, yellow fever, Rift Valley fever, chikungunya, Venezuelan encephalitis, and malaria.

ENCEPHALITIS

Several mosquito-borne viruses that occur in California can cause encephalitis. The majority of humans infected with these viruses have no symptoms. Those individuals with so-called mild symptoms can still have significant illness and face prolonged recovery, and severe cases can be fatal or cause permanent neurological damage. There are several species of mosquitoes in California that can transmit WNV, SLE, and WEE viruses to people and animals. The most important species belong to the group *Culex*. Specifically *Cx. tarsalis*, *Cx. pipiens*, and *Cx. quinquefasciatus* are significant public health concerns because of their widespread distribution throughout the state, their proximity to humans, and their capacity as very efficient vectors.

MALARIA

Malaria is caused by four species of protozoa. The parasites destroy red blood cells causing severe fever and anemia. Left untreated, malaria can cause kidney failure, coma, and death.

Malaria was once a common public health threat in California and much of the southern United States, but it was eradicated by intensive mosquito control efforts and the discovery of anti-malarial drugs. However, the disease still occurs in many other countries worldwide, creating a perpetual risk of re-introduction, especially from infected travelers and immigrants. The *Anopheles* mosquitoes capable of transmitting malaria still occur in many areas of California.

CANINE HEARTWORM

Canine heartworm occurs worldwide. It is caused by a filarial nematode transmitted by *Aedes* mosquitoes that can infect domestic dogs, wild canines (e.g., foxes, coyotes, wolves), and cats. The tiny worms migrate through the body to the heart and cause thickening and inflammation of the heart, which can lead to difficulty in breathing, chronic cough, and vomiting, and can sometimes be fatal.

NUISANCE PESTS

Many species of mosquitoes are not important as vectors of disease, but can cause serious injury and discomfort to humans and animals. Each time a female mosquito pierces the skin to take blood, she contaminates the wound with her saliva, creating the potential for a mild allergic reaction. The common symptom of mosquito bites is irritated and swollen skin surrounding the bite with persistent itching for several days. Scratching these bites to alleviate the itching can result in secondary bacterial infections. In addition, when mosquito populations explode, the sheer number of mosquitoes attempting to bite can make life miserable.

MOSQUITO HABITATS OF CALIFORNIA

Mosquitoes thrive in a wide variety of ecosystems and habitat types, from the subarctic to the tropics and from alpine to desert regions. California's diverse habitats support over 50 species of mosquitoes, each with specific requirements for larval development.

Environmental factors that mosquitoes use when selecting a site to lay eggs include shade or sun exposure, standing or flowing water, salt content, presence of vegetation, and organic content. Examples of natural mosquito breeding sites include fresh and saltwater marshes, lakes, ponds, intermittent creeks and streams, flooded riparian corridors, sloughs and seasonal wetlands, snow-melt pools, and treeholes. Examples of artificial sites include stormwater detention basins, wastewater ponds, flood control basins and channels, spreading grounds, street drains and gutters, wash drains, roadside ditches, animal troughs, tires, fountains, artificial containers, ornamental fish ponds, swimming pools, and various areas that surround residential or commercial buildings. Additional information on the larval habitats of California mosquitoes is provided in Appendix E.

PERMANENT AND SEMI-PERMANENT WATERS

A variety of habitats with permanent, semi-permanent, or seasonal sources of standing water are suitable for mosquito larvae, particularly those in the *Anopheles*, *Culex*, and *Culiseta*

genera. Examples include artificial containers, treeholes, catch basins, open ditches, retention/detention ponds, ponds and wetlands, still waters along the borders of flowing streams, irrigation ditches with vegetation, tree holes, semi-permanent ponds and wetlands. These sources of water can be found in highly urban areas or undeveloped land and often support multiple generations of mosquitoes each season. In warmer climates, urban sources can produce some species of mosquitoes year round.

INTERMITTENT WATERS

Areas that are intermittently or seasonally flooded are the preferred habitat for *Aedes* mosquitoes. Some *Aedes* can develop from egg to adult in four days. Water that stands for more than 96 hours can support *Culex* mosquitoes as well. Irrigated pastures, rice fields, seasonally flooded duck clubs, tidal wetlands, and snowmelt pools are some examples of intermittent or seasonally flooded habitats. These sources of water can be among the most productive sources of mosquitoes because they are often free of natural predators.

MONITORING MOSQUITO POPULATIONS AND MOSQUITO-BORNE DISEASES

In 2000, CDPH collaborated with the University of California, Davis, the California Department of Food and Agriculture, local mosquito and vector control agencies, and other state and local agencies to develop a comprehensive statewide surveillance program to monitor WNV activity. More than 70 local mosquito and vector control districts and agencies, environmental health agencies, and county public health departments throughout California routinely contribute to the program. Surveillance includes testing for WNV infections in humans, horses, mosquitoes, wild birds, and "sentinel" chicken flocks located throughout California. The program also includes testing dead birds reported by the public for infections with WNV. A special website (http://www.westnile.ca.gov) and toll-free hotline (877-WNV-BIRD) were created and maintained by CDPH to support this surveillance program. The information from the program allows CDPH to identify conditions conducive to WNV transmission and areas with elevated risk. This information is provided to local mosquito control agencies so the threat to public health is mitigated to the best of their ability.

Monitoring mosquito populations and mosquito-borne disease levels provides the necessary data to make informed management decisions at the state and local level. IPM programs rely on surveillance data to direct control operations including the use of BMPs.

MOSQUITO SURVEILLANCE TECHNIQUES

Collecting baseline data on mosquito populations and mosquito-borne disease helps target educational efforts and is essential to evaluate control efforts. Thresholds established through a collaborative effort between local mosquito and vector control agencies, CDPH, and other state agencies determine when mosquito populations are controlled. The likelihood of reducing mosquito breeding sites, the level of control desired by those in the area, public safety, land use type, and funding are used to establish treatment thresholds. These thresholds minimize the risk of disease and public nuisance.

LARVAL SURVEILLANCE

Larval surveillance involves routine sampling of aquatic habitats for developing mosquitoes. The primary tool is the "dip count" which indicates whether a habitat is suitable and also estimates larval density. A one-pint cup attached to a long handle is used to collect a standard volume of water ("dip sample"). The "dip count" may be expressed as the number of immature (larvae and pupae) mosquitoes per dip, per unit volume, or per unit surface area of the site.

ADULT SURVEILLANCE

Several types of traps are used for adult surveillance since mosquitoes are attracted to different traps depending on their species, sex, and physiological condition. The most common traps use light, carbon dioxide, water for egg laying, and a resting area. Trapped adults provide information about local distribution, density, and identity. The size of an adult mosquito population can also be assessed by the number and distribution of service requests from the public. Data are used to help locate new sources of mosquitoes or known sources with a recurrent problem.

VIRUS SURVEILLANCE

Detecting antibodies to WNV in "sentinel" chicken flocks, equine cases, and testing dead birds and adult mosquitoes for infections are all used to determine whether WNV is being transmitted in an area. Several species of mosquitoes are routinely tested for the presence of WNV; testing of *Culex* is emphasized. Trapped females are identified and separated into pools of ≤ 50 females each by local vector control agencies. The "pools" are tested at the University of California at Davis, Center for Vectorborne Diseases (CVEC) with the polymerase chain reaction (PCR), to detect the presence of WNV, SLE, and/or WEE. Some local mosquito and vector control agencies also test mosquitoes for virus in their laboratories. Although generally less sensitive than sentinel chickens, mosquito infections may be detected earlier in the season than chicken seroconversions and therefore provide an early warning of virus activity. Information on the status of mosquito-borne encephalitis virus is disseminated to all mosquito control agencies in the state in a weekly summary sent out by CDPH.

BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL

BMPs for mosquito control refer to the implementation of appropriately-chosen mosquito control practices as part of multi-disciplinary programs designed to ensure effective and efficient control of mosquitoes with the least possible environmental cost. Cost, personnel constraints, access to mosquito sources, potential impacts on non-target species or habitat, and adverse effects on wildlife, including threatened and endangered species and permitting requirements, may limit whether mosquito management practices are implemented.

INTEGRATED PEST MANAGEMENT

IPM is a comprehensive approach for managing populations of pests with an array of complimentary methods which include biological control, preventive cultural practices, and strategically using pesticides. IPM of mosquitoes focuses on controlling larvae to suppress adult populations. The core components of mosquito IPM are 1) surveillance for mosquito larvae and adults, 2) establishing action thresholds, 3) selecting appropriate control strategies such as habitat modification, using natural predators, and applying pesticides, and 4) providing education programs. Implementing an IPM program is determined by factors such as habitat type, existing animals and plants, permitting requirements, and the target species of mosquitoes. When properly executed, IPM is an effective, environmentally sensitive, and cost-effective approach to managing mosquito populations.

MOSQUITO CONTROL PRACTICES

More than 70 local agencies including mosquito and vector control districts, environmental health departments, and county health departments actively engage in mosquito control and/or surveillance in California. Personnel from these agencies are certified by CDPH and are trained to control mosquitoes safely and effectively using IPM. Source reduction (i.e., minimizing mosquito breeding areas) is the most effective preventive action because it reduces the habitat available for larval development; however, other modifications of habitat and/or water management can be equally successful. Biological control agents, including native or introduced predators, are often combined with water management practices. Pesticides specific for controlling larvae or adults are used when preventive methods are not possible or unsuccessful.

Compounds currently approved for larval and adult mosquito control in California are listed in Appendix F. Health and Safety (H&S) Codes [Sections 2060-2067, 100170, and 100175] regulate mosquito control practices in California, and are briefly summarized in Appendix G.

LARVAL CONTROL

Larval control is the foundation of most mosquito control programs. Whereas adult mosquitoes are widespread in the environment, larvae must have water to develop; control efforts therefore can be focused on aquatic habitats. Minimizing the number of adults that emerge is crucial to reducing the incidence and risk of disease. The three key components of larval control are environmental management, biological control, and chemical control.

ENVIRONMENTAL MANAGEMENT

Manipulating or eliminating potential mosquito breeding sources can provide dramatic reductions in mosquito populations. There are three levels of environmental management.

1. SOURCE ELIMINATION

This approach completely eliminates potential habitats for mosquitoes. This strategy is generally limited to artificial habitats created by urbanization. Examples of source elimination include emptying or over-turning containers holding water, filling in holes containing water with sand or gravel, cleaning drainage ditches of debris, and covering structures and vessels that could hold water.

2. SOURCE REDUCTION

This strategy aims to alter and sometimes eliminate available habitat for larvae which substantially reduces mosquito breeding and the need for repeatedly applying pesticides. Unlike source elimination, standing water may exist but the total amount of water, or the time the water is left standing, is greatly reduced. Source reduction may require some maintenance (see below) to prevent further mosquito breeding. Examples of source reduction include limiting the growth of emergent vegetation in wetlands and ponds, constructing drainage ditches to remove water from areas prone to flooding, and clearing stormwater channels of silt and debris. Routine larval monitoring can indicate whether these efforts are effective or need further action.

3. SOURCE MAINTENANCE

When eliminating or significantly altering mosquito breeding sources is prohibited and/or inappropriate, reducing the number of sheltered, predator-free habitats while having minimal impact on the surrounding environment can make an area unsuitable for mosquitoes. Source maintenance can include water management, vegetation management, wetland infrastructure maintenance, and wetland restoration. Strategic, focused plans must be developed for each site.

BIOLOGICAL CONTROL

Biological control uses predators, parasites, or pathogens to reduce populations of mosquito larvae and is often combined with environmental management to enhance results. Although many animals will opportunistically consume mosquito larvae, they rarely occur in populations that are significant. As a result, mosquito control agencies stock select predators and/or modify habitats, where appropriate, to create situations that favor predators over mosquito larvae. Several biological control agents can decrease mosquito larvae populations (e.g., mosquito-eating fish, parasitic nematodes, crustaceans such as "tadpole shrimp" and copepods, and dragonfly nymphs). Each can control mosquitoes in certain conditions and/or environments, but fish are the most widely used and successful.

The mosquitofish *Gambusia affinis* has been used to control mosquitoes in California since 1921 and is the most widely used biological control agent in the world. These small fish are effective against mosquito larvae because they grow and reproduce rapidly, feed at the water surface where mosquito larvae are found, and tolerate a wide range of temperature and water quality. Other fish that are used with mixed success include guppies, sticklebacks, river perch, and chubs. Fish are most effective in permanent ponds and wetlands, but are also used in rice fields and stormwater canals with permanent water. Many local mosquito control agencies propagate mosquito-eating fish; however, cost, habitat type, and regulatory exclusion from sensitive habitats limits where they may be distributed.

CHEMICAL CONTROL

Pesticides that control mosquito larvae are called larvicides. Four types of larvicides (bio-rational, surface oil, growth regulating, and chemical products) encompassing seven active ingredients are registered for use in California. Larvicides are applied by hand, from hand-held or vehicle-mounted engine-driven blowers, or by aircraft, depending on the product, the formulation, and the target habitat. Applicators of any of these products must be certified by the CDPH.

1. BIO-RATIONAL PRODUCTS

Bio-rational products exploit insecticidal toxins found in certain naturally occurring bacteria. These bacteria are cultured in mass and packaged in various formulations. The bacteria must be ingested by mosquito larvae so the toxin is released. Therefore bio-rational products are only effective against larvae since pupae do not feed. The bacteria used to control mosquito larvae have no significant effects on non-target organisms.

Two products that are used against mosquito larvae singly or in combination are *Bacillus thuringiensis israelensis* (Bti) and *Bacillus sphaericus* (Bs). Manufactured Bti contains dead bacteria and remains effective in the water for 24 to 48 hours; some slow release formulations provide longer control. In contrast, Bs products contain live bacteria that in favorable conditions remain effective for more than 30 days. Both products are safe enough to be used in water that is consumed by humans.

2. SURFACE AGENTS

Mosquito larvae and pupae breathe through siphons that extend above the water surface. Surface agents such as highly refined mineral oils or monomolecular films (alcohol derivatives) can spread across the entire surface of the water and prevent mosquitoes from breathing. Depending on the product, the film may remain on the water's surface from a few hours to a few days. Surface films are the only available products that are effective against fully developed larvae and pupae. Using surface agents may be restricted in sensitive habitats or where runoff may enter sensitive habitats.

3. INSECT GROWTH REGULATORS

Insect growth regulators (IGRs) disrupt the physiological development of larvae thus preventing adults from emerging. The two products currently used for controlling mosquito larvae are methoprene and diflubenzuron.

The effective life of these products varies with the formulation. Methoprene can be applied in granular, liquid, pellet, or briquette formulation. Diflubenzuron is used selectively because it may be toxic to non-target aquatic invertebrates. There are no such restrictions to using methoprene. IGRs for mosquito control can be used in sources of water that are consumed by humans.

4. CHEMICAL LARVICIDES

Chemical pesticides are rarely used to control mosquito larvae. Organophosphate larvicides are used infrequently because of their negative impacts on non-target organisms and the environment. Temephos is currently the only organophosphate registered for use as a larvicide in California. This product can be safely and effectively used to treat temporary water or highly polluted water where there are few non-target organisms and/or livestock are not allowed access. The efficacy of temephos may be up to 30 days depending on the formulation.

ADULT CONTROL

Adult mosquitoes can only be controlled with pesticides, known as adulticides. Many mosquito control programs in California include adulticiding as an integral component of their IPM program. Adulticiding falls into two categories—barrier applications and ultra-low volume (ULV) applications. Barrier applications target resting mosquitoes by applying pesticides to vegetation and structures. Barrier applications are typically applied on small properties.

ULV applications are used to control adult mosquitoes over large areas. Tiny oil or water droplets carrying an "ultra-low volume" of insecticide (usually not exceeding two ounces per acre) are emitted from specialized equipment mounted to trucks or aircraft. The droplets kill adult mosquitoes on contact. ULV applications are made after sunset or before sunrise to

Adult mosquitoes are controlled when action levels or thresholds are reached or exceeded. Thresholds are based on local sampling of the adult mosquito population and/or when the risk of mosquito-borne disease increases above levels established by the statewide WNV Surveillance and Response Plan. Thresholds are an integral component of mosquito control because they provide a range of predetermined actions based on quantified data. Thresholds also establish expectations and boundaries for responses that ensure appropriate mosquito control activities are implemented timely. The threshold for adult mosquito control depends on several factors including:

- How local citizens tolerate nuisance mosquitoes by evaluating public service requests.
- Overall mosquito abundance.
- Presence of mosquito-borne disease in the region.
- Abundance of mosquito species that are vectors of disease.
- Local acceptance of adult mosquito control activities.
- Climate data.

coincide with the time that mosquitoes are most active, when non-target insects are least active, and when temperature inversions are most likely to occur. These applications are considered when mosquito populations must be reduced immediately to halt disease transmission. Multiple applications are usually required for successful reduction of mosquito numbers.

Adverse effects from ULV applications are rare; however, people with health problems should be aware when and where the applications are being conducted. This information can be obtained by contacting the local vector control agency. Chemicals currently registered for ULV applications against mosquitoes in California (as of December 2007) include organophosphates (e.g., malathion and naled), pyrethrins (e.g., pyrethrum), and pyrethroids (e.g., resmethrin, sumithrin, and permethrin). Formulations of both pyrethrins and pyrethroids include the synergist piperonyl butoxide (PBO), which increases their activity against mosquitoes.

1. ORGANOPHOSPHATES

Malathion and naled are neurotoxins. Malathion is typically used early and late in the season.

2. PYRETHRINS

Pyrethrins are natural insecticides derived from chrysanthemum flowers. Adult mosquitoes are rapidly paralyzed and killed on contact. Pyrethrins are degraded rapidly by sunlight and chemical processes. Residual pyrethrins from ULV applications typically remains less than one day on plants, soil, and water.

3. PYRETHROIDS

Pyrethroids are manufactured pyrethrins. They have very low toxicity to birds and mammals but are toxic to fish if misapplied.

EVALUATION OF THE EFFICACY OF BMPS

The efficacy of particular BMP strategies can be determined by sampling local populations of mosquitoes and assessing the risk of mosquito-borne disease transmission. The information can also be used to better characterize the most effective and efficient strategies for an individual location or land-use type. When existing data or current sampling methods are not sufficient, a specific plan should be developed with the local mosquito and vector control agency. Factors such as treatment costs, proximity to densely populated areas, mosquito-borne disease activity, species present, treatment options, and ability to collaborate with local vector control agencies should be considered when evaluating the best approach for a particular location. After BMPs have been implemented, they should be continuously evaluated. Surveillance for potential sources of mosquitoes and mosquito-borne virus transmission should be ongoing.

Individuals can help protect themselves from mosquitoes and mosquito-borne diseases by following some basic guidelines. The fundamental protective measures include: 1) applying mosquito repellents when outdoors, especially between dusk and dawn when mosquitoes are most active, 2) wearing protective clothing, and 3) maintaining fine mesh screens on windows and doors to prevent adult mosquito entry into homes.

PERSONAL PROTECTIVE MEASURES

The most commonly used mosquito repellents contain the active ingredient DEET (N,N-diethyl-meta-toluamide), which has been formulated and sold under a variety of trade names. Repellents are available in a variety of concentrations and are formulated as aerosol sprays (most commonly at 15%), lotions, and solids (up to 100%). Spray repellents can be used on outer clothing as well as sparingly on the skin to ensure complete coverage. Repellents should not be used under clothing. The percentage of DEET in the repellent reflects the approximate length of time the product will repel mosquitoes (e.g., 23.8% DEET = about five hours of protection, 20% = about four hours, and 6.6% DEET = about two hours). Products must be used according to their labels. Repellents that contain oil of lemon eucalyptus and picaridin are similar in efficacy to those with DEET, but require more frequent application. Impregnated clothing and others materials (which contain permethrin rather than DEET) are also available.

COORDINATION BETWEEN STATE AGENCIES AND LOCAL MOSQUITO AND VECTOR CONTROL AGENCIES

More than 70 mosquito and vector control agencies have been established in California since 1915. Together, these agencies cover approximately 60,000 square miles and protect more than 85% of California residents. These agencies control mosquito larvae and adults, monitor mosquito-borne diseases, and provide information to the communities they serve. The scope and range of agency activities is determined by location, climate, and available resources.

Areas in California that are not within the jurisdiction of an established mosquito control program should coordinate with the closest mosquito and vector control agency or health department. Agencies with land holdings that are not in the jurisdiction of an established mosquito and vector control agency should consult the CDPH's West Nile Virus Preparedness Checklist for Regions without Organized Mosquito Control. This can be found at: http://www.westnile.ca.gov/resources.php

Each state agency should develop a cooperative agreement with a local mosquito and vector control agency that includes identifying areas that produce mosquitoes, coordinating control activities, and developing and monitoring the most effective BMPs. The state agency is responsible for providing reasonable access for mosquito control, monitoring, and implementing BMPs. Shorelines must be accessible for regular control of emergent vegetation and populations of mosquitoes.

LOCAL VECTOR CONTROL SERVICES IN CALIFORNIA

Existing Vector Service Areas

RECOMMENDATIONS FOR STATE-OWNED PROPERTIES

California state law requires the Department of General Services (DGS) to maintain a complete and accurate inventory of all state-owned property. All state land-holding entities must report their land inventory as well as new land and property acquisitions to the Real Estate Services Division of DGS, as required by California Government Code Section 11011, where the information is entered and maintained in the Statewide Property Inventory (SPI) database (http://www.leginfo.ca.gov/calaw.html). The SPI database is used as a centralized property management tool for the State's property.

The 44 state entities identified as agencies managing state-owned properties are listed in Appendix B. Agencies within the State of California with major land holdings include: California State Parks, Department of Water Resources, California State University, University of California, Department of Forestry and Fire Protection, State Lands Commission, Department of Corrections and Rehabilitation, Department of Transportation, and the Department of Fish and Game. The responsibilities of individual state agencies are further explained in Key Agency Responsibilities (Appendix C).

BMPs that are included in this plan are for general guidance that when implemented can reduce mosquito production. Since resources, land use, and land management strategies vary among state agencies and among specific sites, the selection and implementation of specific BMPs will vary accordingly. The local health department, vector control agency, and/or CDPH can provide more information about mosquitoes, WNV, or other mosquito-borne diseases to help select appropriate BMPs for specific problem areas.

GENERAL RECOMMENDATIONS FOR MANAGERS OF STATE-OWNED PROPERTIES

- Coordinate with local mosquito control agencies to monitor mosquito populations and WNV.
- Collaborate with mosquito control professionals to establish the treatment threshold of mosquito populations based on facts related to local health, public safety, and economics.
- Identify and implement BMPs most appropriate for the land-use type, resource availability, WNV risk, and mosquito populations.
- Coordinate any BMP implementation with the local mosquito and vector control agency.
- Ensure mosquito control staff has permanent access and permission to survey standing water for mosquito production and apply control measures.
- Use IPM (biological, mechanical, cultural, microbial, biochemical, and chemical control) to actively control mosquitoes while considering human health, ecological impact, feasibility, and cost effectiveness.
- Eliminate artificial mosquito breeding sites.
- Ensure that all surface water is gone within four days (96 hours) to prevent mosquito breeding.
- Control plant growth in ponds, ditches, and shallow wetlands.
- Design facilities and water conveyance and/or holding structures to minimize the potential for producing mosquitoes.
- Use appropriate bio-rational control measures to control mosquito larvae.
- Use personal protective measures to prevent mosquito bites.
- Evaluate the effects and efficacy of treatments for mosquito control.

BUILDINGS AND GROUNDS

Many state agencies manage buildings and grounds such as prisons and correctional institutions, military properties, university campuses and education department facilities, fairgrounds, hospitals, office buildings, residences, and museums. Water that can produce mosquitoes may be associated with irrigation breaks and/or runoff, clogged gutters, artificial containers, agricultural plantings, stormwater management structures, ornamental ponds, swimming pools, and miscellaneous landscape features.

Mosquito breeding can be minimized by taking precautions such as inspecting and maintaining the property and regularly removing standing water.

GENERAL MOSQUITO MANAGEMENT GUIDELINES

1. Basic information about mosquitoes and simple measures that minimize mosquito breeding habitats should be provided to managers of buildings and grounds. This information should include guidance on eliminating artificially created mosquito breeding sites, properly managing water features, taking personal protection measures, and contacting local and state agencies responsible for mosquito control. A variety of educational brochures are available from CDPH (see http://westnile.ca.gov). Local mosquito and vector control agencies can also provide technical guidance or assistance.
2. Measures to reduce mosquito breeding near buildings and grounds begin with evaluating places where water is present or may accumulate. Minimizing sources of standing water is most effective if begun in the early spring and continued through fall as needed. Inspections should be performed at least weekly or more frequently after rain, particularly during warm weather. Water should not stand for more than 96 hours. Emergent vegetation and debris that can clog gutters and accumulate in the water should be removed.
3. When sources of standing water are too large to be managed properly, the local mosquito and vector control agency should be consulted.

SPECIFIC MOSQUITO REDUCTION BMPS

ELIMINATE ARTIFICIAL MOSQUITO BREEDING SITES

- Examine all outdoor grounds and drain unnecessary water that may stand longer than 96 hours.
- Dispose of unwanted or unused artificial containers.
- Properly dispose of old tires.
- If possible, drill drainage holes, cover, or invert any container or object that holds standing water that must remain outdoors. Be sure to check for containers or trash in places that may

be hard to see, such as under bushes or under the facility.

- Clean clogged rain gutters and storm drains. Keep outdoor drains flowing freely and clear of leaves, vegetation, and other debris.
- Aerate ornamental ponds to avoid letting water stagnate.
- Change water in birdbaths, fountains, buckets, flower pots, and animal troughs at least once per week.
- Clean and chlorinate swimming pools. Keep unused pools empty and dry.
- Minimize sites mosquitoes can use for refuge by thinning branches, trimming and pruning ornamental shrubs and bushes, and keeping grass mowed short.

MANAGE SPRINKLERS AND IRRIGATION SYSTEMS

Overwatering, broken components, and poorly designed irrigation systems in landscaping, parks, and irrigated pastures and fields commonly create standing water that can produce mosquitoes.

- Avoid over-irrigating to prevent excess pooling and runoff.
- Back-fill low-lying areas that hold water for more than 96 hours.
- Improve drainage channels and grading to minimize potential for standing water.
- Design new irrigation systems to increase water efficiency.
- Keep drainage ditches free of excessive vegetation and debris to provide rapid drainage, but retain ground cover to prevent soil loss.
- Reduce seepage as much as possible by repairing ditches and drains.
- Check outdoor faucets and sprinklers and repair any leaks or broken components.
- Report any evidence of standing water to responsible maintenance personnel.

IRRIGATED PASTURES AND AGRICULTURAL FIELDS

Flood irrigation is always a risk for producing mosquitoes. The following recommendations have been adapted from Lawler and Lanzaro 2005.

- Eliminate standing water from pastures and fields. Fields may need to be graded to allow for proper drainage, efficient water flow, and to reduce low-lying areas where standing water may accumulate. Low-lying areas should be filled or leveled accordingly.
- Reuse wastewater through return flow systems to effectively minimize mosquito production and conserve water. Eliminate and reuse excess water that may typically stagnate and collect at lower levels of irrigated fields.
- Irrigate pastures and fields only enough to wet the soil to the depth of rooting and only as frequently as needed to maintain proper soil moisture.
- Drain water within 24 hours following irrigation. Proper drainage is achieved with good slopes to encourage runoff to collect in properly flowing drainage ditches.
- Install surface drains to remove excess water that collects at lower levels of irrigated fields.
- Inspect fields for drainage and broken checks to see whether re-leveling or reconstruction of

levees is needed. Broken checks create cross-leakage that provide habitat for mosquitoes.
- If possible, use closed conduits instead of open canals for water conveyance.
- Do not over fertilize. Excess fertilizers can leach into irrigation run-off, making mosquito production more likely in ditches or further downstream.
- When possible, use sprinklers to apply water rather than flood irrigation.

BIOLOGICAL CONTROL

- Ornamental ponds and other water features may be stocked with mosquitofish available from local mosquito control agencies. However, their use is restricted in natural bodies of water or in water features that drain into natural bodies of water. Land managers must consult with the local mosquito control agencies regarding proper use of mosquitofish or other available biological control agents.

PERSONAL PROTECTIVE MEASURES

- Provide visitors and guests with information regarding the risk of mosquito-borne disease transmission and personal protective measures.
- Install and maintain tight-fitting window and door screens on buildings.
- If possible, minimize outdoor activities at dawn and dusk when mosquitoes are the most active.
- Wear protective clothing such as long sleeved shirts and long pants when going into mosquito-infested areas.
- Use mosquito repellent when necessary, carefully following the directions on the label.

DEPARTMENT OF FISH AND GAME

Over 1,000,000 acres of California lands are managed by the California Department of Fish and Game (DFG) and assisted by the Lands Program. In total, DFG manages 711 properties throughout California. Over two-thirds of the total acreage is classified as wildlife areas; these properties provide habitat for a rich diversity of fish, wildlife, and plant species and represent every major ecosystem in the state.

WETLANDS

Wetlands are the primary source of mosquito production on DFG-managed lands. Under the California Wildlife Protection Act, the term "wetlands" is defined as any lands which may be covered periodically or permanently with shallow water, which include saltwater marshes, freshwater marshes, open or closed brackish water marshes, swamps, mudflats, fens, and vernal pools (Fish & Game Code Section 2785). There are five major classifications of wetlands: marine, estuarine, lacustrine, riverine, and palustrine. Marine and estuarine wetlands are associated with marine waters and include coastal wetlands, such as tidal marshes. Lacustrine wetlands are associated with lakes, while riverine wetlands are found alongside rivers and streams. Palustrine wetlands may be isolated or connected wet areas and include marshes, swamps, and bogs.

Historically, wetlands were considered only as breeding grounds for mosquitoes and as impediments to development. As a result, an estimated 85-90% of California's wetlands were converted to agricultural and urban uses, and water that flooded these wetlands was diverted for other purposes and needs. Wetlands are now known to provide many critical functions in the environment including protecting and improving water quality (sediment accretion, filtration, or nutrient uptake), flood control and groundwater recharge, erosion control, wildlife habitat, biological diversity, and outdoor recreation. Many wetlands provide vital habitats for wildlife and plants and are protected under various laws.

Certain DFG-managed wetlands (e.g., in the Central Valley of California) are classified as either seasonal, semi-permanent, or permanent, depending on the timing and duration of surface waters. Seasonally flooded wetlands can produce formidable numbers of mosquitoes, whereas semi-permanent and permanent wetlands usually produce far fewer mosquitoes because of their limited acreage, stable water levels, and abundance of predators of mosquito larvae.

> Due to the delicate and sometimes protected ecosystems managed by DFG, the sites' natural resources biologists, managers, and staff from the relevant vector control agency must collaborate to control mosquitoes. Source reduction and source maintenance can be combined with using specific larvicides judiciously to minimize mosquito production from these habitats.

GENERAL MOSQUITO MANAGEMENT GUIDELINES

1. Land managers should be provided with basic information about mosquitoes and simple measures to minimize mosquito breeding. This includes information for managing mosquitoes in wetland habitats, personal protection measures, and the contact information of local and state agencies responsible for mosquito control. A variety of educational brochures are available from CDPH (See http://westnile.ca.gov). Local mosquito and vector control agencies can also provide technical guidance or assistance.
2. When potential sources of mosquitoes are too large to be managed properly, the local mosquito and vector control agency should be consulted.
3. Vegetation must be managed routinely; activities such as annually thinning rushes and cattails and removing excess vegetative debris enables natural predators to hunt mosquito larvae more effectively in permanent wetlands. Vegetation in shallow, temporary wetlands can be mowed when dry.
4. Improving water flow through the wetland system minimizes stagnant water and facilitates movement of fish and other natural predators. For example, mosquitoes in coastal tidal wetlands can be managed by constructing and maintaining ditches that drain off the water when the tide falls.
5. The time when seasonal wetlands are flooded can be altered to reduce the overlap with peak mosquito activity.
6. The amount of fertilizer and/or manure flowing into wetlands should be minimized using proper irrigation drainage; fertilizers should be used conservatively. Buffers between agriculture fields and wetlands should be established.

SPECIFIC MOSQUITO REDUCTION BMPS

Information within this section has been partially adapted from Kwasny et. al. 2004. Based on the site activities and potential for mosquito production, the existing BMPs may need to be modified or supplemented to address public health risk, goals and management strategy issues, and requirements of DFG, the local mosquito and vector control agency, and CDPH.

WATER MANAGEMENT PRACTICES FOR SEASONAL WETLANDS

1. TIMING OF FLOODING

- Delay or "phase" fall flooding of wetlands known to produce large numbers of mosquitoes and/or those in close proximity to urban areas to minimize late season mosquito production.
- Strategically locate wetlands identified for early flooding. Wetlands that are flooded in early fall should not be close to urban areas or historically produce great numbers of mosquitoes.

2. SPEED OF FLOODING

- Flood wetlands as quickly as possible to reduce the potential for large numbers of mosquitoes. Coordinate flooding with neighbors and/or the water district to maximize flood-up rate.

3. WATER CONTROL

- Maintain stable water levels in wetlands that are flooded during summer and early spring to prevent intermittent flooding of shoreline areas favorable to mosquito production. Water level fluctuation can be minimized by continuing a constant flow of water into the wetland.
- Circulate water to avoid stagnation (e.g., provide a constant influx of water equal to the net loss or discharge of water).
- Maintain water depths as deep as possible (18-24 inches or more) during the initial flood-up to minimize shallow habitats preferred by mosquito larvae. Shallow water levels can be maintained outside of the mosquito breeding season.
- Flood wetlands with water from permanent water sources containing mosquito predators (i.e., mosquito-eating fish or invertebrate predators) to passively introduce mosquito predators. Permanent wetlands and brood ponds used as flooding sources can be stocked with mosquito-eating fish or maintained to encourage natural predator populations.
- Use a flood-drain-flood regime to control *Aedes* mosquitoes; flood to trigger hatching of dormant mosquito eggs, drain water and larvae into an area where they can be easily treated, drowned in moving water, or consumed by predators, and immediately reflood wetland. This water management regime should be used only when it does not conflict with water quality regulations.

4. FREQUENCY AND DURATION OF IRRIGATION*

- When possible, reduce the number and duration of irrigations to minimize standing water. The need to irrigate should be evaluated based on spring habitat conditions and plant growth. Extended duration irrigations (generally 14-21 days) may be considered for weed control (e.g., cocklebur). Additional measures to offset the potential for increased mosquito production may be needed.
- When possible, managed wetlands should be drawn-down in late March or early April and irrigated in late April or early May when the weather is cooler and mosquitoes are less of a problem.
- Irrigate managed wetlands before soil completely dries after spring draw-down to discourage floodwater mosquitoes from laying eggs in the dry, cracked substrate.
- Drain irrigation water into ditches or other water sources with mosquito predators instead of nearby dry fields.
- Maintain high ground water levels by keeping channels or deep swales permanently flooded for subsurface irrigation to reduce the amount of irrigation water needed during the mosquito season.

**Note: Spring and summer irrigation is a common wetland management practice used to increase seed production and biomass of moist-soil plants, and reduce competition from undesirable plants in seasonal wetlands.*

5. EMERGENCY PREPAREDNESS

- Whenever feasible, have an emergency plan that provides for immediate drainage into acceptable areas if a public health emergency occurs.

VEGETATION MANAGEMENT PRACTICES

- Manage vegetation based on local land management objectives and associated habitat uses to minimize mosquito production. Methods of vegetation control for managed wetlands include mowing, burning, disking, and grazing.
- Manage the spread and density of invasive, non-native emergent wetland vegetation to increase native plant diversity, increase the mobility of larval mosquito predators, and allow for more efficient penetration of chemical control agents.
- Manage the spread and density of floating and submerged vegetation that encourages mosquito production (i.e., water hyacinth, water primrose, parrot's feather, duckweed, and filamentous algal mats).

WETLAND INFRASTRUCTURE MAINTENANCE

1. Inspect levees at least annually and repair as needed.
2. Periodically inspect, repair, and clean water control structures.
    - Remove all debris, including silt and vegetation, which can impede drainage and water flow.
    - Ensure water control structures are watertight to prevent unnecessary water flow or seepage.
3. Regularly remove trash, silt and vegetation from water delivery ditches to allow efficient water delivery and drainage.
    - Remove problem vegetation that inhibits water flow using herbicides or periodic dredging.
    - If possible, use closed conduits instead of open canals for water conveyance.
4. Periodically test and repair pumps used for wetland flooding to maximize pump output.

WETLAND RESTORATION AND ENHANCEMENT FEATURES

Design wetlands with features that minimize the potential for producing mosquitoes.

- Include, when possible, independent inlets and outlets in the design of each wetland unit.
- Provide adequate water control structures for complete draw-down and rapid flooding.
- Design swales with adequate slopes so the majority of the wetland can be drawn down.
- Install cross-levees where appropriate to improve the ability to rapidly flood and irrigate. "Underwater" levees that isolate irrigation water during the spring but can be overtopped during fall and winter flooding can also be built.
- Construct or improve ditches with at minimum slope of 2:1 and four-foot depth to prevent unwanted vegetation growth and/or unnecessary seepage. Consider a 3:1 slope or greater to discourage damage from burrowing animals and minimize potential seepage problems.
- Construct, improve, or maintain levees to quality standard (minimum >3:1 slopes and >80% compaction) to ensure stability and prevent unwanted seepage. Consider slopes 5:1 or greater in areas prone to overland flooding and levee erosion.
- Excavate deep channels or basins to maintain permanent water greater than 2.5 feet

deep within a portion of seasonal managed wetlands. This provides year-round habitat for mosquito predators, which can inoculate seasonal wetlands when they are irrigated or flooded.

- Maintain separate permanent water reservoirs used to convey water to seasonal wetlands. These provide year-round habitat for mosquito predators, which inoculate seasonal wetlands when they are irrigated or flooded.

BIOLOGICAL CONTROL

- Flood managed wetlands from permanent-water sources containing mosquito predators (e.g., mosquito-eating fish or invertebrate predators) to passively introduce mosquito predators. Permanent wetlands and brood ponds can be stocked with mosquitofish or native predatory species.
- Maintain permanent or semi-permanent waters where larval mosquito predators can develop and thrive. Discourage the use of broad spectrum pesticides.

PERSONAL PROTECTIVE MEASURES

- Provide visitors and guests with information regarding the risk of mosquito-borne disease transmission and personal protective measures.
- Install and maintain tight-fitting window and door screens on buildings.
- If possible, minimize outdoor activities at dawn and dusk when mosquitoes are the most active.
- Wear protective clothing such as long-sleeved shirts and long pants when going into mosquito-infested areas.
- Use mosquito repellent when necessary, carefully following the directions on the label.

DEPARTMENT OF TRANSPORTATION

The California Department of Transportation's (Caltrans) land holdings include: the California state highway system, highway right-of-way, right-of-way acquisitions, stormwater conveyance and treatment devices, operational facilities, rock quarries, gravel pits, sand and earth borrow pits, offices, shops, storage yards, replacement housing, parks adjoining or near any state highways, and environmental mitigation sites.

RIGHT OF WAYS

The Division of Right-of-Way (RW) oversees right-of-way acquisitions required for transportation purposes and comprehensively manages the Caltrans Real Property Program, reducing the costs of operations and disposing of property no longer needed for transportation purposes. In addition, RW acquires, maintains, and leases suitable residential, non-residential, and airspace properties to public and private third parties. Airspace property is defined as "any property within operating State highway right-of-way limits that is capable of other development and can safely accommodate a secondary use without interference with the operation and foreseeable future expansion of the highway without endangering the traveling public." Examples of such secondary uses include parking lots, self-storage units, commercial businesses, light industry, and cellular telephone towers. Many of these land-use types have the potential to produce significant mosquito populations if not properly designed and maintained.

STORMWATER INFRASTRUCTURE

The Caltrans Storm Water Program oversees the development of stormwater management infrastructure associated with roadways and facilities that provide both flood protection and non-point pollution mitigation as required by federal and state clean water laws. Rapid dewatering from roadways is prioritized to protect motorists. Typical components of stormwater infrastructure include drain inlets, catch basins, conveyance pipes, and structural treatment devices to remove suspended pollutants. Structural treatment devices are the most variable infrastructure components. Examples include vegetated swales, dry detention basins, ponds and constructed wetlands, media filtration devices, and trash capturing devices. Because of their function in runoff water management, structural treatment devices often provide habitats suitable for mosquito production.

GENERAL MOSQUITO MANAGEMENT GUIDELINES

1. Basic information should be provided to district managers and supervisors on mosquitoes and on simple measures to minimize mosquito breeding habitats on state property. At a minimum, managers and supervisors should be provided with information on eliminating artificially created mosquito breeding sites around buildings and facilities, proper management of water features and stormwater infrastructure, personal protection measures, and the contact information of the local and state agencies responsible for mosquito control. A variety of

educational brochures are available from CDPH (See http://westnile.ca.gov). In addition, the local mosquito and vector control agency can provide technical guidance or assistance.

2. Reducing mosquitoes around buildings and other facilities should begin with evaluating places where water is present or may accumulate. Even small amounts of water may produce mosquitoes. Minimizing actions are most effective in the early spring and should be continued as needed through fall. Facilities should be evaluated at least weekly or more frequently after rain, particularly during warm weather. Water should not stand for more than 96 hours. Emergent vegetation and debris that can clog gutters and accumulate in the water should be minimized.
3. The design, construction, and maintenance of stormwater infrastructure must be considered carefully due its strong potential for producing mosquitoes. The two key components for minimizing mosquitoes in the majority of these systems are to fully discharge captured water in 96 hours or less and provide routine maintenance to maintain this function. Permanent sources including wetlands, ponds, sumps, and basins require control measures that minimize habitat suitable for mosquitoes and may require routine mosquito control with insecticides. Mosquito control agencies can help develop plans to minimize or eliminate mosquito production.
4. Mosquito and vector control agencies should be contacted to provide expert evaluation, consultation, and control.

SPECIFIC MOSQUITO REDUCTION BMPS

ELIMINATE ARTIFICIAL MOSQUITO BREEDING SITES

- Examine all outdoor grounds and drain unnecessary water that may stand longer than 96 hours.
- Dispose of unwanted or unused artificial containers.
- Properly dispose of old tires.
- If possible, drill drainage holes, cover, or invert any container or object that holds standing water that must remain outdoors. Be sure to check for containers or trash in places that may be hard to see, such as under bushes or under the facility.
- Clean clogged rain gutters and storm drains. Keep outdoor drains flowing freely and clear of leaves, vegetation, and other debris.
- Aerate ornamental ponds to avoid letting water stagnate.
- Change water in birdbaths, fountains, buckets, flower pots, and animal troughs at least once per week.
- Clean and chlorinate swimming pools. Keep unused pools empty and dry.
- Minimize sites mosquitoes can use for refuge by thinning branches, trimming and pruning ornamental shrubs and bushes, and keeping grass mowed short.

MANAGE SPRINKLERS AND IRRIGATION SYSTEMS

Overwatering, broken components, and poorly designed irrigation systems in landscaping, parks, and irrigated pastures and fields commonly create standing water that can produce mosquitoes.

- Avoid over-irrigating to prevent excess pooling and runoff.
- Back-fill low-lying areas that hold water for more than 96 hours.

- Improve drainage channels and grading to minimize potential for standing water.
- Design new irrigation systems to increase water efficiency.
- Keep drainage ditches free of excessive vegetation and debris to provide rapid drainage, but retain ground cover to prevent soil loss.
- Reduce seepage as much as possible by repairing ditches and drains.
- Check outdoor faucets and sprinklers and repair any leaks or broken components.
- Report any evidence of standing water to responsible maintenance personnel.

BIOLOGICAL CONTROL

- Ornamental ponds and other water features may be stocked with mosquitofish available from local mosquito control agencies. However, their use is restricted in natural bodies of water or in water features that drain into natural bodies of water. Land managers must consult with the local mosquito control agencies regarding proper use of mosquitofish or other available biological control agents.

PERSONAL PROTECTIVE MEASURES

- Provide visitors and guests with information regarding the risk of mosquito-borne disease transmission and personal protective measures.
- Install and maintain tight-fitting window and door screens on buildings.
- If possible, minimize outdoor activities at dawn and dusk when mosquitoes are the most active.
- Wear protective clothing such as long-sleeved shirts and long pants when going into mosquito-infested areas.
- Use mosquito repellent when necessary, carefully following the directions on the label.

STORMWATER INFRASTRUCTURE

Based on the site activities and potential for mosquito production, the existing BMPs may need to be modified or supplemented to address public health risk, water quality goals, stormwater management issues, and requirements of the local mosquito and vector control agency, Caltrans, and CDPH. Information within this section has been partially adapted from Metzger et al. 2003 and Metzger 2004.

STORMWATER CONVEYANCE

1. Provide a uniform grade between the inlets and outlets to ensure that all water is discharged in 96 hours or less. Routine inspection and maintenance are crucial to ensuring the grade remains as designed and to remove blockages of trash and debris.
2. Keep inlets free of trash and debris to prevent standing water from backing up on roadways and gutters.
3. Design outlets to prevent scour depressions that can hold standing water.

DRY TREATMENT SYSTEMS

1. Design structures such that they do not hold standing water for more than 96 hours to prevent mosquito development. Features to prevent or reduce the possibility of clogged discharge orifices (e.g., debris screens) should be incorporated into the design. The use of weep holes is not recommended due to rapid clogging.
2. Provide a uniform grade between the inlets and outlets to ensure that all water is discharged in 96 hours or less. Routine inspection and maintenance are crucial to ensuring the grade remains as designed.
3. Avoid the use of electric pumps. They are subject to failure and often require permanent-water sumps. Structures that do not require pumping should be favored over those that have this requirement.
4. Avoid the use of loose rock rip-rap that may hold standing water.
5. Design distribution pumping and containment basins with adequate slopes to drain fully. The design slope should take into consideration buildup of sediment between maintenance periods.

TREATMENT SYSTEMS WITH SUMPS OR BASINS

1. Where possible, completely seal belowground structures that retain water permanently or semi-permanently in sumps or basins (e.g., CDS™, Stormfilter™, Delaware-type sand media filters) to prevent entry of adult mosquitoes. If using covers or screens, maximum allowable gaps of 1/16th inch (2 mm) will exclude entry of adult mosquitoes. Inspect barriers frequently and replace when needed.
2. If the sump or basin is completely sealed against mosquitoes, with the exception of the inlet and outlet, the inlet and outlet should be completely submerged to reduce the available surface area of water for mosquitoes to lay eggs (female mosquitoes can fly through pipes).
3. Where possible, design belowground sumps with the equipment necessary to allow for easy dewatering of the unit.

PERMANENT TREATMENT PONDS AND CONSTRUCTED TREATMENT WETLANDS

1. Whenever possible, stock permanent ponds and constructed wetlands with mosquito-eating fish available from local mosquito control agencies.
2. Design and maintain accessible permanent pond shorelines to allow for periodic maintenance and/or control of emergent and pond-edge vegetation, and routine monitoring and control of mosquitoes. Emergent plant density should be routinely maintained so mosquito predators can move throughout the vegetated areas or are not excluded from pond edges.
3. Whenever possible, design and maintain permanent ponds with deep zones in excess of four feet to limit the spread of invasive emergent vegetation such as cattails. The pond edges below the water surface should be as steep as practicable and uniform to discourage dense plant growth that may provide immature mosquitoes with refuge from predators and increased nutrient availability.
4. Use concrete or liners in shallow areas to discourage plant growth where vegetation is not necessary.

5. Whenever possible, provide a means for easy dewatering when/if needed.
6. Manage the spread and density of floating and submerged vegetation that encourages mosquito production (i.e., water hyacinth, water primrose, parrot's feather, duckweed, and filamentous algal mats).
7. If possible, compartmentalize managed treatment wetlands so the maximum width of ponds does not exceed two times the effective distance (40 feet) of land-based application technologies for mosquito control agents.

GENERAL ACCESS REQUIREMENTS FOR STORMWATER TREATMENT STRUCTURES

1. All structures should be easily and safely accessible, without the need for special requirements (e.g., Occupational Safety and Health Administration requirements for "confined space"). This will allow vector control personnel to effectively monitor and, if necessary, abate vectors.
2. If utilizing covers, the design should include spring-loaded or lightweight access hatches that can be easily opened.
3. Provide all-weather road access (with provisions for turning a full-size work vehicle) along at least one side of large aboveground structures that are less than 21 feet, or both sides if shore-to-shore distance is greater than 21 feet. Note: Mosquito larvicides are applied with hand held equipment at small sites and with backpack or truck mounted high-pressure sprayers at large sites. The effective swath width of most backpack or truck-mounted larvicide sprayers is approximately 18–21 feet on a windless day.
4. Build access roads as close to the shoreline as possible to allow for maintenance and vector control crews to periodically maintain, control and remove emergent vegetation and conduct routine mosquito monitoring and abatement. Remove vegetation and/or other obstacles between the access road and the structure that might obstruct the path of larvicides to the water.
5. Control vegetation (by removal, thinning, or mowing) periodically to prevent barriers to access.

STATE PARKS

The California State Park (CSP) System supports the most diverse assemblage of natural resources of any land management agency in California. CSP is the most ecologically diverse system in California; of all California's 202 major habitat types (alliance level), 65% exist within CSP. Of the 1,552,328 acres in the CSP, 94% are managed specifically for their value as natural resources and 78% is classified as State Park or State Reserve, where habitat preservation is the highest objective. Of all CSP acreage, 94% remains as native habitat; the remaining 6% has been converted for use as facilities (http://www.parks.ca.gov/?page_id=23509). State parks protect and preserve a diverse collection of culturally and environmentally sensitive structures and habitats, threatened plant and animal species, ancient Native American sites, historic structures, and artifacts. State park resources include underwater preserves, reserves, and parks; redwood, rhododendron, and wildlife reserves; state beaches, recreation areas, wilderness areas, and reservoirs (e.g., dunes, marshes, lakes, streams, rivers, deserts, forests, meadows, and grasslands); state historic parks, historic homes, Spanish era adobe buildings (e.g., museums, visitor centers, cultural reserves, and preserves); lighthouses, ghost towns, waterslides, conference centers, and off-highway vehicle parks.

More than 85 million people visited California State Parks during the 2005-06 fiscal year. Almost half of California's state parks are adjacent to urban or residential development. Mosquito surveillance and control measures must be considered to protect the large number of people that visit the lands or live nearby.

GENERAL MOSQUITO MANAGEMENT GUIDELINES

1. Basic information should be provided to district managers and supervisors on mosquitoes and on simple measures to minimize mosquito breeding habitats on state property. At a minimum, managers and supervisors should be provided with guidance on eliminating artificially created mosquito breeding sites around buildings and facilities, proper management of water features and stormwater infrastructure, taking personal protection measures, and contacting local and state agencies responsible for mosquito control. A variety of educational brochures are available from CDPH (See http://westnile.ca.gov). In addition, the local mosquito and vector control agency can provide technical guidance or assistance.
2. When potential sources of mosquitoes are too large to be managed properly, the local mosquito and vector control agency should be consulted.

SPECIFIC MOSQUITO REDUCTION BMPS FOR DEVELOPED AND UNDEVELOPED AREAS

Based on the site activities and potential for producing mosquitoes, the existing BMPs may need to be modified or supplemented to address public health risk, goals, and land-use strategies. The requirements of CSP, the local mosquito and vector control agency, and CDPH must also be considered.

DEVELOPED AREAS

ELIMINATE ARTIFICIAL MOSQUITO BREEDING SITES

- Examine all outdoor grounds and drain unnecessary water that may stand longer than 96 hours.
- Dispose of unwanted or unused artificial containers.
- Properly dispose of old tires.
- If possible, drill drainage holes, cover, or invert any container or object that holds standing water that must remain outdoors. Be sure to check for containers or trash in places that may be hard to see, such as under bushes or under the facility.
- Clean clogged rain gutters and storm drains. Keep outdoor drains flowing freely and clear of leaves, vegetation, and other debris.
- Aerate ornamental ponds to avoid letting water stagnate.
- Change water in birdbaths, fountains, buckets, flower pots, and animal troughs at least once per week.
- Clean and chlorinate swimming pools. Keep unused pools empty and dry.
- Minimize sites mosquitoes can use for refuge by thinning branches, trimming and pruning ornamental shrubs and bushes, and keeping grass mowed short.

MANAGE SPRINKLERS AND IRRIGATION SYSTEMS

Overwatering, broken components, and poorly designed irrigation systems in landscaping, parks, and irrigated pastures and fields commonly create standing water that can produce mosquitoes.

- Avoid over-irrigating to prevent excess pooling and runoff.
- Back-fill low-lying areas that hold water for more than 96 hours.
- Improve drainage channels and grading to minimize potential for standing water.
- Design new irrigation systems to increase water efficiency.
- Keep drainage ditches free of excessive vegetation and debris to provide rapid drainage, but retain ground cover to prevent soil loss.
- Reduce seepage as much as possible by repairing ditches and drains.
- Check outdoor faucets and sprinklers and repair any leaks or broken components.
- Report any evidence of standing water to responsible maintenance personnel.

WILDLANDS—UNDEVELOPED AREAS

California encompasses about 100 million acres of land. Approximately 75 million acres are classified as wildlands, which include all undeveloped and non-cultivated property in the state. Approximately 2.3 million acres in actual property and easements are owned by the state, primarily under the control of the Departments of Fish and Game, CSP, and the Department of Forestry and Fire Protection. Mosquito surveillance and monitoring for public health issues and targeted areas for mosquito control should be identified, especially if resources are limited and wildlands cannot be modified. Collaboration with local vector control agencies is essential for limiting resource expenditure.

MONITORING AND SURVEILLANCE

- Conduct ongoing mosquito larvae surveillance and evaluation of larval populations on wildlands that produce mosquitoes capable of migrating into populated areas.
- Collect and monitor data from mosquito traps, complaints, and reports from the public.
- Correlate seasonal records with weather data to evaluate trends. Monitor larval and adult mosquito distribution.
- Accurately identify, map, and monitor areas that may produce mosquitoes. Tailor control measures for each site, contingent on the species of mosquitoes that are present.

BIOLOGICAL CONTROL

- Ornamental ponds and other water features may be stocked with mosquitofish available from local mosquito control agencies. However, their use is restricted in natural bodies of water or in water features that drain into natural bodies of water. Land managers must consult with the local mosquito control agencies regarding proper use of mosquitofish or other available biological control agents.
- Stabilize water levels to encourage colonization by natural predators of mosquito larvae.

PERSONAL PROTECTIVE MEASURES

- Provide visitors and guests with information regarding the risk of mosquito-borne disease transmission and personal protective measures.
- Install and maintain tight-fitting window and door screens on buildings.
- If possible, minimize outdoor activities at dawn and dusk when mosquitoes are the most active.
- Wear protective clothing such as long-sleeved shirts and long pants when going into mosquito-infested areas.
- Use mosquito repellent when necessary, carefully following the directions on the label.

CONSERVANCIES

In order to promote the conservation of its land resources, the state has created nine state "conservancies" that acquire and protect undeveloped lands in specific regions of the state. The conservancies are departments of the Resources Agency charged with acquiring land in specified geographical areas in order to advance specific goals. California's conservancies are diverse with a range of organizational structures, functions, and statutory objectives. While the statutory goals of each conservancy differ, the conservancies were created because it was perceived that vital land resources were endangered by development or other threats.

These conservancies include:

- Baldwin Hills Conservancy
- California Tahoe Conservancy
- Coachella Valley Mountains Conservancy
- San Diego River Conservancy
- San Gabriel & Lower Los Angeles Rivers & Mountains Conservancy
- San Joaquin River Conservancy
- Santa Monica Mountains Conservancy
- Sierra Nevada Conservancy
- State Coastal Conservancy

MOSQUITO REDUCTION BMPS

Based on site activities and potential for producing mosquitoes, the existing BMPs may need to be modified to address public health risk, goals and land-use issues, and requirements of the respective conservancies, the local mosquito and vector control agency, and CDPH.

MONITORING AND SURVEILLANCE

- Conduct ongoing mosquito larvae surveillance and evaluation of larval populations on conservancies that produce mosquitoes capable of migrating into populated areas.
- Collect and monitor data from mosquito traps, complaints, and reports from the public.
- Correlate seasonal records with weather data to evaluate trends. Monitor larval and adult mosquito distribution.
- Accurately identify, map, and monitor areas that may produce mosquitoes. Tailor control measures for each site, contingent on the species of mosquitoes that are present.

BIOLOGICAL CONTROL

- Ornamental ponds and other water features may be stocked with mosquitofish available from local mosquito control agencies. However, their use is restricted in natural bodies of water or in water features that drain into natural bodies of water. Land managers must consult with the local mosquito control agencies regarding proper use of mosquitofish or other available biological control agents.

PERSONAL PROTECTIVE MEASURES

- Provide visitors and guests with information regarding the risk of mosquito-borne disease transmission and personal protective measures.
- Install and maintain tight-fitting window and door screens on buildings.
- If possible, minimize outdoor activities at dawn and dusk when mosquitoes are the most active.
- Wear protective clothing such as long-sleeved shirts and long pants when going into mosquito-infested areas.
- Use mosquito repellent when necessary, carefully following the directions on the label.

REFERENCE

SOURCES CITED IN THE DOCUMENT

Alameda County Mosquito Abatement District. http://www.mosquitoes.org/index.htm

American Mosquito Control Association. TG Floore (ed). 2007. Biorational Control of Mosquitoes. Bulletin 7. Supplement 23(7). 330 pp.

Association of State and Territorial Health Officers. 2005. Public Health Confronts the Mosquito: Developing Sustainable State and Local Mosquito Control Programs. 62 pp.

Boyce, K. W. and D. A. Brown. 2003. Integrated vector management guidelines for adult mosquitoes. J. Am. Mosq. Control Assoc. 19: 448-451.

California Department of Public Health. 2008. Overview of Mosquito Control Practices in California. http://www.westnile.ca.gov/resources.php

California Department of Public Health, Mosquito and Vector Control Association of California, and University of California. 2007. California Mosquito-Borne Virus Surveillance and Response Plan. http://www.westnile.ca.gov/resources.php

California Department of Public Health. 2007. West Nile Virus Infection Prevention and Control Recommendations, California Long-term Care Facilities. http://www.westnile.ca.gov/resources.php

California Department of Transportation. 2006 Right-of-Way Property Management and Airspace Storm Water Guidance Manual. http://www.dot.ca.gov/hq/row/rwstormwater/index.htm

California Environmental Resources Evaluation System and the California Wetlands Information System. http://ceres.ca.gov/wetlands/

Centers for Disease Control and Prevention. 2003. Epidemic/Epizootic West Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control. http://www.cdc.gov/ncidod/dvbid/westnile/resources/wnvguidelines2003.pdf

Contra Costa Clean Water Program. 2004. Vector Control Plan. http://www.cccleanwater.org/Publications/CCCWP%20Vector%20Control%20Plan%20Final.pdf

Darsie, RF Jr., and RA Ward. 2005. Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico. Univ. Press of Florida, Gainesville ,383pp.

Eldridge BF. 1998. Mosquitoes: Integrated Pest Management Around the Home. Pest Notes. University of California, ANR Publication: 7451.

Jouganatos, GA, and RAH Goodfellow. 2001. An Inventory Study of the State of California's Land Holdings. California State University, Sacramento.

Kwasny, DC, M Wolder, and CR Isola. 2004. Technical Guide to Best Management Practices for Mosquito Control in Managed Wetlands. Central Valley Joint Venture's Mosquito Working Group, U.S. Bureau of Reclamation.

Lawler SP. 2004. Managing Mosquitoes in an Agricultural Situation. University of California, Pest Management Guidelines: Rice. University of California, ANR Publication: 3465.

Lawler SP, and GC Lanzaro. 2005. Managing Mosquitoes on the Farm. University of California, ANR Publication: 8158.

Metzger ME, DF Messer, CL Beitia, CM Myers, and VL Kramer. 2002. The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs. Stormwater 3(2):24-39.

Metzger ME, CM Myers and VL Kramer. 2003. The "Dark Side" of Stormwater runoff management: Vectors associated with BMPs. Proceedings of the California Mosquito and Vector Control Association. 70:2-10.

Metzger ME. 2004. Managing Mosquitoes in Stormwater Treatment Devices. University of California, ANR Publication: 8125.

Meyer RP, Reisen WK, Vector and Vector-borne Disease Committee. 2003. Integrated Mosquito Surveillance Guidelines. Sacramento, California: Mosq. Vector Control Assoc. Calif.

O'Malley CM. 1989. Guidelines for Larval Surveillance. Proceedings of the 76th New Jersey Mosquito Control Association Annual Meeting: 45-55.

Reeves WC, Asman SM, Hardy JL, Milby MM, and Reisen WK. 1990. Epidemiology and control of mosquito-borne arboviruses in California, 1943-1987. Sacramento, Calif: Calif. Mosq.Vector Control Assoc.

Reisen WK and Lothrop HD. 1999. Effects of sampling design on the estimation of adult mosquito abundance. J Am Mosq Control Assoc. 15:104-114.

Sacramento-Yolo Mosquito and Vector Control District. 2007. Mosquito Reduction Best Management Practices Implementation Program Policies. Elk Grove, CA: Sacramento-Yolo MVCD.

Sacramento-Yolo Mosquito and Vector Control District. 2005. Mosquito and Mosquito-Borne Disease Management Plan. Elk Grove, CA: Sacramento-Yolo MVCD.

Stockwell PJ, Wessell N, Reed DR, Kronenwetter-Koepel TA, Reed KD, Turchi TR, and Meece JK. 2006. A Field Evaluation of Four Larval Mosquito Control Methods in Urban Catch Basins. J Am Mosq Control Assoc. 22(4): 666-671.

United States Environmental Protection Agency. 2004. The Use of Best Management Practices (BMPs) in Urban Water Sheds. National Risk Management Research Laboratory.

Walton WE. 2003. Managing Mosquitoes in Surface-Flow Constructed Wetlands. University of California, ANR Publication: 8117.

Walton WE. 2005. Protocol for Mosquito Sampling for Mosquito Best Management Practices on State of California-Managed Wildlife Areas. University of California, Riverside.

Washington State Department of Ecology, Water Quality Program. 2004. Best Management Practices for Mosquito Control.

World Health Organization. 1982. Manual on Environmental Management for Mosquito Control with Special Emphasis on Malaria Vectors. http://whqlibdoc.who.int/publications/1982/9241700661_eng.pdf

LIST OF ACRONYMS

AMCA	American Mosquito Control Association
BMP	Best Management Practices
Bs	*Bacillus sphaericus*
Bti	*Bacillus thuringiensis israelensis*
Caltrans	California Department of Transportation
CDC	Centers for Disease Control and Prevention
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
CSP	California State Parks
CVEC	Center for Vectorborne Diseases (UC Davis)
DFG	California Department of Fish and Game
DGS	California Department of General Services
DPR	California Department of Pesticide Regulation
EPA	Federal Environmental Protection Agency
H&S Codes	Health and Safety Codes
IPM	Integrated Pest Management
MVCAC	Mosquito and Vector Control Association of California
PCR	Polymerase Chain Reaction
SGVMVCD	San Gabriel Valley Mosquito and Vector Control District
SLE	St. Louis encephalitis virus
SYMVCD	Sacramento-Yolo Mosquito and Vector Control District
UCD	University of California, Davis
UCR	University of California, Riverside
VRDL	CDPH Viral and Rickettsial Disease Laboratory
WEE	Western equine encephalomyelitis virus
WNV	West Nile virus

RESOURCES FOR ADDITIONAL INFORMATION

MOSQUITO BIOLOGY

Additional information on mosquitoes and mosquito-borne diseases is obtainable from a variety of reputable sources. More information on mosquito biology and ecology is available on the American Mosquito Control Association (AMCA) and the Mosquito and Vector Control Association of California (MVCAC) websites. Local mosquito and vector control agencies and their respective websites can provide detailed information about local mosquito species. Information on mosquito-borne diseases is available from the U.S. Centers for Disease Control and Prevention (CDC) and the CDPH websites. Contact information for local mosquito and vector control agencies can be found through the CDPH website by entering the zip code of the location of interest under **"LOCATE YOUR LOCAL MOSQUITO AND VECTOR CONTROL AGENCY"** at http://westnile.ca.gov; more information is available on the MVCAC website.

1. AMCA website: http://www.mosquito.org
2. MVCAC website: http://www.mvcac.org
3. CDPH West Nile virus website: http://westnile.ca.gov
4. CDC website: http://www.cdc.gov

MONITORING MOSQUITOES AND DISEASES

- More information about reporting dead birds and WNV surveillance in California can be found at http://www.westnile.ca.gov.
- Methods for sampling adult mosquitoes and guidelines for designing, operating, and processing of traps are discussed in Guidelines for Integrated Mosquito Surveillance (Meyer et al. 2003) and are summarized in Appendix B of the California Mosquito-Borne Virus Surveillance and Response Plan which can be found at: http://westnile.ca.gov/resources.php
- For federal WNV guidelines see the Centers for Disease Control and Prevention, Epidemic/Epizootic West Nile Virus in the United States: Guidelines for Surveillance, Prevention and Control http://www.cdc.gov/ncidod/dvbid/westnile/resources/wnv-guidelines-aug-2003.pdf
- For information specific for wildlife areas see Walton WE. 2005. Protocol for Mosquito Sampling for Mosquito Best Management Practices on State of California-Managed Wildlife Areas. University of California.

BEST MANAGEMENT PRACTICES

- A list of products commonly used to control adult mosquitoes in California is included in Appendix F. A list of Health and Safety Codes that are pertinent to mosquito control is included in Appendix G.
- For additional information on personal protective measures and the use of chemical repellents, go to the CDC web site at: http://www.cdc.gov/ncidod/dvbid/westnile/qa/insect_repellent.htm.
- For more information on evaluating the efficacy of BMPs on state of California-managed Wildlife Areas, see Walton 2005.

APPENDICES

APPENDIX A

Governor's West Nile Virus Emergency Proclamation of August 2, 2007

A PROCLAMATION OF A STATE OF EMERGENCY

WHEREAS when compared to the same time last year, there has been a three-fold increase in the number of people infected by West Nile virus; and

WHEREAS since 2002, West Nile virus has infected hundreds of people and caused multiple deaths in California, including four deaths this year; and

WHEREAS the recent upturn in foreclosures this year has increased the number of vacant homes this summer with unattended and untreated pools, which has exacerbated the spread of West Nile virus; and

WHEREAS local governments have made sustained efforts to minimize the spread of the virus, and the state has supplemented these efforts by dedicating over $15 million over the last three years to mitigate the virus's effects; and

WHEREAS despite those efforts to eradicate West Nile virus, the virus remains a threat, and further efforts to control the spread of the virus and to reduce and minimize the risk of infection are needed; and

WHEREAS the Mosquito Vector Control Association of California, which is composed of 61 local vector control districts, is seeking state assistance in addressing the potential for a West Nile virus epidemic in California; including a request for funding for surveillance activity and abatement efforts; and

WHEREAS control of West Nile virus may require immediate actions to limit the population of adult mosquitoes and mosquito larvae, and those actions may include the ground and aerial application of pesticides in urban, suburban and rural areas; and

WHEREAS there are also numerous and significant incidents of Valley Fever, especially in Kern County; and

WHEREAS due to the magnitude of the threat, the size of the affected areas and the need to control the spread of the virus across jurisdictional boundaries, the conditions are beyond the control of the services, personnel, equipment and facilities of any single county, city and county, or city, and require the combined forces of a mutual aid region or regions; and

WHEREAS under section 8558(b) of the California Government Code, I find that conditions of extreme peril to the safety of persons and property exist within the Counties of Kern, Colusa and San Joaquin caused by the threat of West Nile virus.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, in accordance with the authority vested in me by the California Constitution and the California Emergency Services Act and, in particular, sections 8625, 8567 and 8571 of the California Government Code, HEREBY PROCLAIM A STATE OF EMERGENCY to exist within Kern, Colusa and San Joaquin Counties, and hereby issue the following orders:

IT IS ORDERED that the Department of Public Health shall allocate up to $1 million dollars as needed, to local vector control agencies to identify potential mosquito habitat and to treat those areas to prevent the spread of West Nile virus in the three above-listed counties and other counties identified by the Department of Public Health.

IT IS FURTHER ORDERED that the Department of Public Health shall allocate up to $350,000 to local vector control agencies for surveillance purposes to provide an early warning of the incidence of West Nile Virus so that proper control measures can be taken by the local vector control agencies to prevent the spread of West Nile virus in the three above-listed counties and other counties identified by the Department of Public Health.

IT IS FURTHER ORDERED that the Department of Public Health shall coordinate with the State and Consumer Services Agency, the Resources Agency and the Department of Food and Agriculture to develop a plan using best management practices for implementation by the appropriate state agencies for the early detection of West Nile virus on state-owned properties and appropriate mitigation and abatement measures. Funds in the amount up to $150,000 shall be allocated for the purpose of developing this plan.

IT IS FURTHER ORDERED that the Department of Public Health and the Department of Food and Agriculture shall work with the Mosquito Research Program at the University of California, Davis, to determine what resources are needed to further advance the research on the ecology and the epidemiology of West Nile virus.

IT IS FURTHER ORDERED that the Department of Public Health shall work with (1) local vector control districts to utilize their existing power pursuant to Health and Safety code section 2053 to inspect and abate vector or public nuisances, with special emphasis on the removal of standing water in untended pools and containers on vacant property; and (2) the Business, Transportation and Housing Agency and local public health departments to notify lenders, realtors, mortgage brokers and others whose responsibilities include managing vacant homes to ensure that pools and other containers that can hold water are drained and maintained empty to prevent the spread of West Nile virus.

IT IS FURTHER ORDERED that the Department of Public Heath shall implement a supplemental program of mosquito control, including health advisories and technical assistance, in the above-listed counties to assist those counties and the mosquito and vector control agencies within those regions to minimize the proliferation of mosquitoes and to reduce the transmission of West Nile virus.

IT IS FURTHER ORDERED that all agencies and departments of state government utilize and employ state personnel, equipment and facilities for the performance of any and all activities consistent with the direction of the Department of Public Health in an effort to address and mitigate this emergency, and consistent with the State Emergency Plan as coordinated by the Office of Emergency Services.

IT IS FURTHER ORDERED that the Department of Public Health enter into such contracts as it deems appropriate, in consultation with the above-listed counties and the mosquito and vector control agencies within those regions, to provide services, material, personnel and equipment to supplement the West Nile virus mitigation efforts in those jurisdictions.

IT IS FURTHER ORDERED that the provisions of the Government Code, the Public Contract Code, the State Contracting Manual and Management Memo 03-10, along with all Department of Public Health policies, applicable to state contracts, including, but not limited to, advertising and competitive bidding requirements and approvals for non-competitively bid contracts, are hereby temporarily suspended with respect to contracts to provide services, material, personnel and equipment to supplement the West Nile virus mitigation and abatement efforts in the above-listed counties to the extent that such laws would prevent, hinder or delay prompt mitigation of the effects of this emergency.

IT IS FURTHER ORDERED that the Department of Public Health shall consult with the county agricultural commissioner prior to the application of "prohibited materials," as defined in subdivision (p) of section 110815 of the Health and Safety Code, to agricultural land used for the production of certified organic foods.

IT IS FURTHER ORDERED that the Department of Public Health work with local public health departments to take appropriate actions to minimize the incidents of Valley Fever in the above-listed counties.

I FURTHER DIRECT that as soon as hereafter possible, this proclamation be filed in the Office of the Secretary of State and that widespread publicity and notice be given to this proclamation.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 2nd day of August 2007.

APPENDIX B

*Summary of State-Owned Properties by Agency**

DEPARTMENT NAME	TOTAL FEE SITE/ FACILITIES	TOTAL FEE ACRES	TOTAL STRUCTURES	TOTAL SQUARE FEET
AIR RESOURCES BOARD, STATE	1	2.25	1	54,000
BOATING & WATERWAYS, DEPT OF	3	22.34	0	0
CAL STATE UNIVERSITY	35	23,159.88	1,641	62,197,552
COACHELLA VALLEY MOUNTAINS CONSERVANCY	6	2,788.55	0	0
COASTAL CONSERVANCY, STATE	26	3,179.32	0	0
CONSERVATION CORPS, CALIFORNIA	4	173.90	59	84,302
CONSERVATION, DEPT OF	2	0.26	1	2,000
CONSUMER AFFAIRS, DEPT OF	1	2.51	1	30,893
CONTROLLER, STATE	1	1.13	0	0
CORRECTION AND REHABILITATION	49	25,945.38	3,760	40,814,744
DEVELOPMENTAL SERVICES	6	2,415.62	539	5,186,281
DISTRICT AGRICULTURAL ASSOCIATIONS	45	3,200.31	1,312	7,689,816
EDUCATION	4	167.29	128	1,047,068
EMPLOYMENT DEVELOPMENT DEPARTMENT	27	42.52	27	527,860
EXPOSITION & STATE FAIR, CALIF	1	854.64	45	1,058,336
FISH AND GAME, DEPT OF	362	581,057.10	755	1,120,191
FOOD AND AGRICULTURE, DEPT OF	13	113.46	110	452,978
FORESTRY & FIRE PROTECTION, DEPT OF	269	74,968.74	2,221	3,879,733
GENERAL SERVICES, DEPT OF	79	1,954.12	128	18,083,988
HEALTH CARE SERVICES, DEPT OF	1	1.11	1	30,500
HEALTH PLANNING & DEVEL, OFC STATEWIDE	1	2.43	0	0
HIGHWAY PATROL, DEPT OF THE CALIF	108	624.94	173	1,109,804
JUDICIAL COUNCIL OF CALIFORNIA	4	6.40	0	0
JUSTICE, DEPT OF	6	10.51	7	150,857
LANDS COMMISSION, STATE	79	4,492,020.90	1	3,325
LEGISLATURE	1	1.55	1	237,000
LOTTERY COMMISSION, CALIFORNIA STATE	1	12.50	2	267,280
MENTAL HEALTH	5	2,692.22	436	6,358,728
MILITARY, DEPT OF	78	5,924.49	487	3,386,540
MOTOR VEHICLES, DEPT OF	96	241.75	97	1,846,285
PARKS & RECREATION, DEPT OF	276	1,236,074.10	5,316	6,349,874
PUBLIC HEALTH, CA DEPARTMENT OF	1	28.96	6	697,153
REHABILITATION, DEPT OF	1	3.20	4	42,278
SAN JOAQUIN RIVER CONSERVANCY	2	1,100.60	1	3,000
SANTA MONICA MOUNTAINS CONSERVANCY	83	8,678.18	51	50,423
SCIENCE CENTER, CALIF	1	152.49	8	485,877
TAHOE CONSERVANCY, CALIF	2	6,274.54	0	0
TOXIC SUBSTANCES CONTROL, DEPT OF	1	52.32	0	0
TRANSPORTATION, DEPT OF	535	6,196.68	1,285	6,212,326
UNIVERSITY OF CALIFORNIA	15	85,296.08	4,027	39,257,723
VETERANS AFFAIRS	13	2,498.21	99	1,598,209
WATER RESOURCES CONTROL BOARD, STATE	1	465.00	0	0
WATER RESOURCES RECLAMATION BOARD	25	19,245.69	0	0
WATER RESOURCES, DEPT OF	48	111,047.00	1	0
TOTAL	**2,318**	**6,698,701.17**	**22,731**	**210,316,924**

** Provided by the Department of General Services, Real Estate Division*

Below is a description of the land holdings with the primary functions of each for the various State of California agencies.

BOATING AND WATERWAYS

This department's land holdings are used for recreational boating.

CALIFORNIA EXPOSITION AND STATE FAIR

The land holdings are for the provision of fairgrounds and all of the associated parking areas.

CALIFORNIA STATE UNIVERSITY

The land holdings, in the broad sense, are used for educational programs. These include, but are not limited to, classroom buildings, faculty offices, student housing, athletic facilities, plant operations, libraries, performing arts, parking facilities, agricultural land and facilities, and natural habitat.

CALIFORNIA TAHOE CONSERVANCY

The land holdings, according to section 66907 of the California Public Resources Code, are for the protection of natural environment, provision of public access or public recreational facilities, and the preservation of wildlife habitat areas.

COACHELLA VALLEY MOUNTAINS CONSERVANCY

This conservancy's land holdings are discussed in California Public Resources Code section 33500 et seq. In sum, the Legislature finds that the Coachella Valley contains "unique and important open-space, wildlife, scenic, environmental, anthropological, cultural, scientific, educational and recreational resources" that should be protected.

COASTAL CONSERVANCY

This conservancy's land holdings are similar to those for the agency discussed above. This includes the protection and ecological improvements of environmentally sensitive lands, particularly wetlands and other wildlife habitats. The conservancy provides public access, and protection of scenic open-space and agricultural lands.

CONSERVATION CORPS

This state entity owns only one property (69.97 acres) consisting of approximately 20 buildings in Auburn, California. This property is used to operate one of its residential programs which provides education, training, disaster response, field administration, and community service for up to one hundred corps members.

CONSERVATION

This department has only two land holdings: a division office and lot in Coalinga, and a parcel of land that has two producing wells in the Los Angeles area.

CONSUMER AFFAIRS

This agency manages one office building.

CORRECTIONS AND REHABILITATION

This department's land holdings are used for prisons, future prisons, spraying fields for distribution of wastewater, agricultural crops and pasture, and buffer space. The 25 rehabilitation centers provide various forms of care for the blind, newly blind, and for those losing their eyesight.

DELTA PROTECTION COMMISSION

The commission has only one property, Staten Island in San Joaquin County.

DEVELOPMENTAL SERVICES

This department maintains five properties (buildings). These properties are developmental services centers located across the state.

EDUCATION

This department maintains six properties providing special educational services and housing for students in the special programs.

EMPLOYMENT DEVELOPMENT

This department manages property that is used to house staff that administer various programs.

FISH AND GAME

The Mission of the Department of Fish and Game is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. The department has 629 properties totaling nearly 900 thousand acres. The main purposes are preserving wildlife habitats, wetlands, and other species habitats. The department is also responsible for the diversified use of fish and wildlife including recreational, commercial, scientific and educational uses.

FOOD AND AGRICULTURE

The land holdings are used for agricultural inspections stations, veterinary laboratories, and a laboratory and greenhouse complex.

FORESTRY AND FIRE PROTECTION

This department's land holdings include fire stations, helitack bases, administrative offices, communication sites, conservation camps, access, and utility easements.

GENERAL SERVICES

This department's properties are largely state office buildings and some surplus properties for disposition.

HIGHWAY PATROL

This department's land holdings are used as headquarters offices, area offices, and communication centers.

JUSTICE

This department's properties are office buildings and courthouses.

LANDS COMMISSION

The purpose of the commission's "School Lands", originally granted to California in 1853 to benefit public education, is to make the properties financially productive for retirees, beneficiaries, and disabled membership of the State Teacher's Retirement System (STRS). The purposes of the commission's "Sovereign Lands" are water dependent commerce, fishing, navigation, recreational activities, ecological preservation, and scientific research.

MENTAL HEALTH

This department's land holdings, which consist of five hospitals and two correctional programs, are used to provide long-term mental health care for those with serious mental illnesses.

MOTOR VEHICLES

This department's land holdings include buildings and facilities that provide services to motorists.

STATE PARKS

This department's land holdings are for the preservation of California's biological diversity, protection of the highly valued natural and cultural resources, and creation of high-quality outdoor recreation. Responsible for almost one-third of California's scenic coastline, California State Parks manages coastal wetlands, estuaries, beaches, and dune systems. State parks consist of nearly 1.4 million acres, with over 280 miles of coastline; 625 miles of lake and river frontage; nearly 15,000 campsites; and 3,000 miles of hiking, biking, and equestrian trails.

SANTA MONICA MOUNTAINS CONSERVANCY

The purpose of this conservancy's property is the formation of an interlinking system of urban, rural, and river parks, open space, trails, and wildlife habitats accessible to the general public.

STATE LOTTERY

The State Lottery owns one property, its headquarters office building.

STATEWIDE HEALTH PLANNING AND DEVELOPMENT

The properties are acquired, through the Cal-Mortgage Insurance Program, by foreclosure caused by debt default. The purpose of acquiring the properties is for their sale in order to satisfy the debt owed to the Cal-Mortgage Insurance Fund.

TRANSPORTATION

This department's land holdings include: highway right-of-way, existing right of-way, operational facilities, rock quarries, gravel pits, sand and earth borrow pits, offices, shops, storage yards, replacement housing, parks adjoining or near any State Highways, environmental mitigation sites, and sundry other uses. Caltrans manages more than 45,000 miles of California's highway and freeway lanes.

UNIVERSITY OF CALIFORNIA REGENTS

The land holdings, in the broad sense, are used for educational programs. These include, but are not limited to, classroom buildings, faculty offices, student housing, athletic facilities, plant operations, libraries, performing arts, parking facilities, agricultural land and facilities, and natural habitat.

VETERAN'S AFFAIRS

The department, through the Farm and Home Loan Division, owns the Sacramento headquarters building and parking lot, the building and surrounding land at the Santa Clara district office, and approximately 33,000 homes held as collateral for contracts of purchase by veterans. The Veteran's Home Division owns the land and various buildings that comprise the Veteran's Homes in Yountville, Barstow, and Chula Vista. In addition, Yountville Veteran's Home owns the land under and surrounding a reservoir and water treatment plant, a waste treatment plant, golf course (leased to a private firm) and a cemetery.

WATER RESOURCES CONTROL BOARD

This board owns one property in Alpine County (resulting from a resolved lawsuit).

WATER RESOURCES

The land holdings of The Division of Land and Right-of-Way are for the State Water Project and Flood Control (of the Reclamation Board).

APPENDIX C

Key State Agency Responsibilities: WNV Surveillance and Control

KEY AGENCY RESPONSIBILITIES

In the State of Emergency Proclamation of August 2, 2007, it was ordered that the California Department of Public Health coordinate with the State and Consumer Services Agency, the Resources Agency and the Department of Food and Agriculture to develop a plan using BMPs for implementation by the appropriate state agency for the early detection of WNV on state-owned properties and appropriate mitigation and abatement measures. In accordance with this plan, all state agencies are given key responsibilities regarding their managed properties as follows: 1) to coordinate with local vector control agencies to ensure that effective surveillance and abatement procedures are conducted, 2) to disseminate information regarding BMPs and mosquito control procedures, and 3) to disseminate information regarding the risks and prevention of WNV.

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

- Collate adult mosquito abundance data submitted by local agencies; provide summary of data to local agencies.
- Provide contact information for local mosquito and vector control agencies by zip code. Available on website: www.westnile.ca.gov
- Maintain a WNV information and dead bird reporting hotline, 1-877-WNV-BIRD, and a WNV website: www.westnile.ca.gov
- Coordinate submission of specimens for virus testing.
- Provide supplies for processing mosquito pool and sentinel chicken diagnostic specimens.
- Test sentinel chicken sera for viral antibodies.
- Maintain data including registration of collection sites, entry of mosquito abundance and pool data, and sentinel chicken sera data through the California Vectorborne Disease Surveillance Gateway http://gateway.calsurv.org
- Test human specimens for virus.
- Distribute a weekly bulletin summarizing surveillance test results.
- Send weekly surveillance results to the University of California, Davis (UCD) interactive website.
- Provide statewide, daily DYCAST human risk maps, available through the California Vectorborne Disease Surveillance Gateway (http://gateway.calsurv.org).
- Provide analysis of DYCAST risk data and notification to local agencies when appropriate.
- Immediately notify local vector control agency and public health officials when evidence of viral activity is found.
- Conduct epidemiological investigations of human vector-borne disease cases.
- Coordinate and participate in a regional emergency response in conjunction with California Office of Emergency Services.
- Conduct active surveillance for human vector-borne disease cases.
- Provide oversight to local jurisdictions without defined vector-borne disease control program.
- Maintain inventory of antigens and antisera to detect exotic viruses.

CENTER FOR VECTORBORNE DISEASES, UNIVERSITY OF CALIFORNIA, DAVIS (CVEC)

- Conduct research on arbovirus surveillance, transmission of mosquito-borne diseases, and mosquito ecology and control.
- Test mosquito pools and dead birds for endemic and introduced viruses.
- Provide a proficiency panel of tests for identification of viruses from human, equine, bird, or arthropod vectors.
- Maintain an interactive website (http://gateway.calsurv.org) for dissemination of mosquito-borne virus information and data.
- Maintain inventory of antigens, antisera, and viruses to detect the introduction of exotic viruses.
- Provide confirmation of tests done by local or state agencies.

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE (CDFA)

- Notify veterinarians and veterinary diagnostic laboratories about WEE and WNV and testing facilities available at UCD CVEC.
- Provide outreach to general public and livestock and poultry producers on the monitoring and reporting of equine and ratite encephalitides.
- Facilitate equine and ratite sample submission from the field.
- Conduct epidemiological investigations of equine cases.

CALIFORNIA ANIMAL HEALTH AND FOOD SAFETY LABORATORY

- Identify dead birds for WNV testing.
- Conduct necropsies and testing on dead birds.
- Submit bird tissues to UCD for testing.
- Test equine specimens for WNV.

LOCAL MOSQUITO AND VECTOR CONTROL AGENCIES

- Gather, collate, and interpret regional climate and weather data.
- Monitor abundance of immature and adult mosquitoes.
- Collect and submit mosquito pools to CVEC for virus detection.
- Maintain sentinel chicken flocks, obtain blood samples, and send samples to CDPH for testing.
- Pick-up and ship dead birds for necropsy and WNV testing, or test oral swabs from American crows locally via rapid antigen screening assays.
- Update CDPH weekly of all birds that are independently reported and/or tested by VecTest, RAMP, or immunohistochemistry.
- Conduct routine control of immature mosquitoes.
- Conduct control of adult mosquitoes when needed.
- Educate public on mosquito avoidance and reduction of mosquito breeding sites.
- Coordinate with local Office of Emergency Services personnel.
- Communicate regularly with neighboring agencies.
- Utilize enforcement processes as appropriate pursuant to the California Health and Safety Code.

GOVERNOR'S OFFICE OF EMERGENCY SERVICES

- Coordinate the local, regional, or statewide emergency response under epidemic conditions in conjunction with CDPH via the Standardized Emergency Management System (SEMS).
- Serve as liaison with the Federal Emergency Management Agency (FEMA) in the event that a federal disaster is declared.

APPENDIX D

MOSQUITOES OF CALIFORNIA

The biology and key characteristics of the four major mosquito genera are described below.

AEDES MOSQUITOES

There are about 80 species of *Aedes* mosquitoes in the continental United States; 24 species occur in California. Certain species are widespread, may occur in very large numbers, and are among the worst biting pests. *Aedes* mosquitoes do not lay their eggs directly on the surface of standing water. Instead, they lay single eggs on intermittently flooded surfaces such as the damp soil around irrigated pastures and fields, along the edges of coastal tidal marshes, and inside dry treeholes and containers. Eggs are extremely resistant to drying and will lie dormant on dry surfaces until flooding occurs (eggs of *Ae. vexans* have been documented to lie dormant for up to three years). This can lead to many generations of eggs in a given habitat if female mosquitoes lay successive batches of eggs before the area is flooded. When flooding occurs, large numbers of eggs hatch spontaneously and develop rapidly to adults. Although larval developmental sites vary greatly, the most productive include transient ground pools, flooded areas along overflowing streams, flood and stormwater control basins, intermittently flooded agricultural lands, and container habitats such as tree holes, wheel ruts, and discarded tires.

Aedes are primarily summer-breeding mosquitoes. Because of their rapid larval development in newly-flooded habitats, adults often emerge before predators can colonize the water source. Most *Aedes* complete two to several generations per year depending on the frequency of habitat flooding from natural and artificial events. Adults cannot survive in colder weather and therefore the majority of *Aedes* overwinter as eggs.

Typically, *Aedes* mosquitoes found in California will not enter buildings and homes; however, they are strong fliers and are known to travel many miles from their aquatic developmental sites to search for hosts. *Aedes* mosquitoes are diurnal (i.e., active during the day) during mild weather, especially around shaded areas, but will also bite at dusk. Most *Aedes* females feed on large mammals like cattle and horses, but will readily feed on humans. *Aedes* mosquitoes are aggressive and persistent biters causing people and animals to avoid areas where their numbers are great. For example, *Ae. nigromaculis* are currently not known to vector disease, but are considered a serious pest because they will seek out human hosts and bite during the day when people are most likely to be outdoors and active.

ANOPHELES MOSQUITOES

Approximately 22 species of *Anopheles* are found in the continental United States and of these, 5 occur in California. When feeding, *Anopheles* adults rest with their abdomens positioned at a distinct angle to the surface of the skin, whereas other species orient their bodies parallel. Females lay single floating eggs directly on the surface of permanent or semi-permanent standing water. A female can lay successive batches of up to 300 eggs during the breeding season. Eggs are not resistant to drying and typically hatch within two-three days, although hatching may take up to two-three weeks in colder climates. Larvae develop in 12 to 20 days, but can take longer in cooler weather. Preferred larval habitats include clear, fresh seepage water in sunlit or partly shaded pools, wetlands, roadside ditches, rice fields, and poorly maintained water troughs.

Adult females bite at dusk and dawn and prefer to feed on mammals. Many *Anopheles* mosquitoes prefer to feed on rabbits, but will also feed on large mammals such as livestock and humans. In California, *Anopheles* species may undergo two or more generations per year. Most species overwinter in protected areas as mated females, resuming activity the following spring. These are among the first mosquitoes to emerge and bite humans each year.

Historically, *Anopheles freeborni*, the western malaria mosquito, was a vector of malaria in California. Currently, with the disease eradicated from California and the United States, it is considered a nuisance mosquito. This species is widespread throughout California and females will lay their eggs in any standing fresh water, although it is most abundant in rice fields or other wetlands during late summer. While most adult mosquitoes stay within a few miles of their breeding source, they will migrate further when seeking hibernation sites in fall. This can lead to a large influx of mosquitoes from uncontrolled areas to residential areas during September and October.

CULISETA MOSQUITOES

Only eight species of *Culiseta* mosquitoes occur in the continental United States, of which four are found in California. Females lay clusters of floating eggs (rafts) on the surface of standing water. *Culiseta* mosquitoes are moderately aggressive biters, attacking in the evening hours or in shade during the day. Peak populations occur during the cooler months. These mosquitoes prefer to feed on larger domestic animals such as cattle and horses, but will also feed on humans. *Culiseta* mosquitoes are currently not considered to be an important public health concern or vector. The distribution of *Cs. inornata*, an unusually large mosquito, is widespread and can be found at elevations of up to 10,000 feet. Larvae of *Cs. inornata* develop in permanent water habitats, including shallow marshes, peat bogs, roadside ditches, abandoned gravel pits, and in standing water in soil cavities left by fallen trees. Mated females of *Cs. inornata* overwinter and are among the earliest mosquitoes to appear the following year.

CULEX MOSQUITOES

Culex, with 11 species found throughout the state, is the second-largest genus of mosquitoes in California, second only to *Aedes*. Females can lay up to six to seven rafts of eggs over a two month life span (although most do not survive this long); each raft contains from 100-300 eggs which are laid on the surface of standing water. *Culex* larvae occur in a broad range of aquatic sites ranging from containers such as discarded tires, water barrels, and flower pots to clogged gutters, catch basins, and water for irrigation and urban wastewater. During summer and periods of drought, areas without regularly flowing water, street drainage systems, and contaminated streams, ponds and pools become productive larval habitats. *Culex* larvae are known for thriving in polluted sources of water with a high organic content.

Culex mosquitoes prefer to take blood meals at dusk or after dark and can be painful and persistent biters. *Culex* preferably feed on birds but also feed on mammals including humans and horses. They readily enter houses and buildings in search of a suitable host. Two or more generations of *Culex* can occur per year. Females that emerge in late summer will mate and overwinter until the following spring or mid-summer.

Several species of *Culex* can transmit viruses that can cause encephalitis (i.e., inflammation of the brain), including WNV, SLE, and WEE. These mosquitoes are efficient and effective vectors of these diseases among birds, humans, horses and many other wild and domestic animals.

CULEX TARSALIS

Culex tarsalis, the western encephalitis mosquito, is one of California's most important and efficient vectors of WNV, SLE, and WEE. This species is widespread in California. *Cx. tarsalis* prefer to lay their eggs on fresh or lightly polluted standing water such as rice fields, ditches, pastures, waste water ponds, and seasonal wetlands. Other more urban freshwater sources include ornamental ponds, storm drains, and flood control channels. Larvae usually develop into adults in approximately 8-14 days; warmer water can shorten the developmental period. *Cx. tarsalis* are active from spring through fall; however the population in the Central Valley peaks in June to July with a secondary, smaller peak in September coinciding with flooding of seasonal wetlands. *Cx. tarsalis* survive through the winter as adults in barns, culverts, caves, and similar dark, protected places.

Adult *Cx. tarsalis* can disperse a great distance up to 10-15 miles in search of blood meals, generally traveling along riparian corridors, but most stay close to the site where they emerged. Adults rest by day in shaded areas such as animal burrows and treeholes. Females prefer feeding between dusk and dawn but may bite during the day in deep shade. Females obtain blood meals from birds or mammals and can transmit diseases between these groups.

CULEX PIPIENS AND *CULEX QUINQUEFASCIATUS*

Culex pipiens (the northern house mosquito) and *Culex quinquefasciatus* (the southern house mosquito) appear to be identical. *Cx. quinquefasciatus* occurs in southern California, whereas *Cx. pipiens* is found along the coastal regions and in northern California and is the most widely distributed mosquito species in the world. Both species can transmit encephalitis viruses. They are common in and around households and prefer to lay eggs in polluted water that is high in organic content such as dairy runoff, wastewater catchment basins, stormwater ponds, dirty flower pots, bird baths, or any drainage systems where standing water exists.

In California, *Cx. pipiens* and *Cx. quinquefasciatus* typically do not disperse from where they emerged. Females feed at dusk or after dark, readily enter homes and prefer avian hosts but will also feed on large mammals including humans. *Cx. pipiens* and *Cx. quinquefasciatus* are vectors of WNV and SLE virus, and have also been implicated in transmitting canine heartworm.

MOSQUITO EGGS

ANOPHELES SPECIES | *AEDES* SPECIES | *CULEX* AND *CULEX* SPECIES

APPENDIX E

*Typical Larval Habitats of California Mosquitoes**

RIPARIAN	VERNAL POOLS	FOUL WATER	SALT MARSH	TREEHOLE
Aedes atropalpus	*Aedes bicristatus*	*Culex pipiens*	*Aedes dorsalis*	*Aedes deserticola*
Aedes washinoi	*Aedes campestris*	*Culex restuans*	*Aedes squamiger*	*Aedes sierrensis*
Aedes pullatus	*Aedes hemiteleus*	*Culex stigmatosoma*	*Aedes taeniorhynchus*	*Orthopodomyia signifera*
Aedes sticticus	*Aedes niphadopsis*	*Culex tarsalis*	*Culex tarsalis*	*Aedes purpureipes*
Aedes vexans	*Aedes ventrovittus*	*Culiseta impatiens*	*Culiseta incidens*	
Culex apicalis	*Culex tarsalis*	*Culiseta incidens*	*Culiseta inornata*	
Culex boharti	*Culiseta incidens*	*Culiseta inornata*		
Culex reevesi	*Culiseta inornata*			
Culex tarsalis	*Psorophora columbiae*			
Culex territans	*Psorophora signipennis*			
Culex thriambus				
Culiseta incidens				
Culiseta particeps				
Culiseta inornata				

SMALL CONTAINER	FRESHWATER MARSH	ROCK POOLS	BACKWATER FISHPONDS	SNOW MELT
Aedes sierrensis	*Anopheles freeborni*	*Aedes sierrensis*	*Aedes sierrensis*	*Aedes cataphylla*
Aedes albopictus	*Anopheles occidentalis*	*Anopheles punctipennis*	*Culex tarsalis*	*Aedes clivis*
Culex pipiens	*Culex erythrothorax*	*Culex tarsalis*	*Culex pipiens*	*Aedes communis*
Culiseta incidens	*Culex tarsalis*	*Culiseta incidens*	*Culex stigmatosoma*	*Aedes fitchii*
			Culiseta incidens	*Aedes hexodontus*
			Culiseta inornata	*Aedes pullatus*
				Aedes sticticus
				Aedes tahoensis
				Culiseta incidens

WOODLAND POOLS	IRRIGATED PASTURES	PERMANENT PONDS
Aedes bicristatus	*Aedes melanimon*	*Aedes schizopinax*
Aedes increpitus	*Aedes nigromaculis*	*Culex erythrothorax*
Aedes washinoi	*Aedes vexans*	*Culex reevesi*
Anopheles punctipennis	*Culex tarsalis*	*Culex tarsalis*
Culex apicalis	*Culiseta inornata*	*Culiseta impatiens*
Culex tarsalis	*Psorophora columbiae*	*Culiseta incidens*
Culiseta incidens		*Culiseta particeps*
Culiseta inornata		*Culiseta inornata*
Culiseta particeps		*Coquillettidia perturbans*
		Uranotaenia anhydo

**From the Alameda Mosquito Abatement District website: http://www.mosquitoes.org/Larhabitat.html*

APPENDIX F

COMPOUNDS APPROVED FOR MOSQUITO CONTROL IN CALIFORNIA

Pesticides used for mosquito control have been evaluated for this purpose by the U.S. Environmental Protection Agency (EPA) and found to pose minimal risks to human health and the environment when used according to label directions. For updated information on specific products approved for use in California, please refer to the California Department of Pesticide Regulation website: http://www.cdpr.ca.gov/docs/label/labelque.htm

The components of this appendix have been adapted from the California Mosquito-Borne Virus Surveillance and Response Plan; California Department of Public Health, Mosquito and Vector Control Association of California, and University of California, please refer to the following website for more information: www.westnile.ca.gov.

Label rates and usage vary from year to year and geographically. Consult your County Agricultural Commissioner and the California Department of Fish and Game before application. Examples of products containing specific active ingredients are provided below, but this is not an inclusive list nor constitutes product endorsement. For more information on pesticides and mosquito control, please refer to the U.S. EPA website: www.epa.gov/pesticides/factsheets/skeeters.htm

LARVICIDES:

1. BACILLUS THURINGIENSIS ISRAELENSIS (Bti)

Product Examples: Aquabac 200G, VectoBac® 12AS, Teknar HP-D
Use: Approved for most permanent and temporary bodies of water.
Limitations: Only works on actively feeding stages. Does not persist well in the water column.

2. BACILLUS SPHAERICUS (Bs)

Product Example: VectoLex® CG
Use: Approved for most permanent and temporary bodies of water.
Limitations: Only works on actively feeding stages. Does not work well on all species. May persist and have residual activity in some sites.

3. INSECT GROWTH REGULATORS (IGRS)

a. (S)-Methoprene
Product Example: Altosid® Pellets
Use: Approved for most permanent and temporary bodies of water.
Limitations: Works best on older instars. Some populations of mosquitoes may show some resistance.

b. Diflurobenzamide
Product Example: Dimilin® 25W
Use: Impounded tail water, sewage effluent, urban drains and catch basins.
Limitations: Cannot be applied to wetlands, crops, or near estuaries.

4. LARVICIDING OILS

Product Example: Mosquito Larvicide GB-1111
Use: Ditches, dairy lagoons, floodwater. Effective against all stages, including pupae.
Limitations: Consult with the California Department of Fish and Game for local restrictions.

5. MONOMOLECULAR FILMS

Product Example: Agnique® MMF
Use: Most standing water including certain crops.
Limitations: Does not work well in areas with unidirectional winds in excess of 10 mph.

6. ORGANOPHOSPHATE COMPOUND (TEMEPHOS)

Product Example: Abate® 2-BG
Use: Non-potable water; marshes; polluted water sites
Limitations: Cannot be applied to crops for food, forage, or pasture. This material may not be effective on some *Culex tarsalis* populations in the Central Valley.

ADULTICIDES:

1. ORGANOPHOSPHATE COMPOUNDS

a. Malathion
Product Example: Fyfanon® ULV
Use: May be applied by air or ground equipment over urban areas, some crops including rice, wetlands.
Limitations: Paint damage to cars; toxic to fish, wildlife and bees; crop residue limitations restrict application before harvest.

b. Naled
Product Example: Dibrom® Concentrate, Trumpet® EC
Use: Air or ground application on fodder crops, swamps, floodwater, residential areas.
Limitations: Similar to malathion.

c. Chlorpyrifos
Product Example: Mosquitomaster 412
Use: Air or ground application in urban or recreational areas
Limitations: Not registered for use over agricultural commodities, or grazing lands and may be toxic to bees, fish, an some wildlife.

2. PYRETHRINS (natural pyrethrin products)

Product Examples: Pyrenone® 2-BG Crop Spray, Pyrenone® 25-5, Evergreen®
Use: Wetlands, floodwater, residential areas, some crops.
Limitations: Do not apply to drinking water, milking areas; may be toxic to bees, fish, and some wildlife. Some formulations with synergists have greater limitations.

3. PYRETHROIDS (synthetic pyrethrin products containing deltamethrin, cyfluthrin, permethrin, resmethrin or sumithrin)

Product Examples: Suspend® Sc, Tempo Ultra Sc, Aqua-Reslin®, Scourge®, Anvil® 10+10 ULV, and Duet
Use: All non-crop areas including wetlands and floodwater.
Limitations: May be toxic to bees, fish, and some wildlife; avoid treating food crops, drinking water or milk production.

PESTICIDES USED FOR LARVAL MOSQUITO CONTROL IN CALIFORNIA

For updated information on specific products approved for use in California, please refer to the California Department of Pesticide Regulation website: http://www.cdpr.ca.gov/docs/label/labelque.htm

LARVICIDES ACTIVE INGREDIENT	TRADE NAME	EPA REG #	MFG	FORMULATION	APPLICATION	PESTICIDE CLASSIFICATION
Bacillus sphaericus, (Bs)	VectoLex CG	275-77	Valent BioSciences	Granule	Larvae	Biorational
Bacillus sphaericus, (Bs)	VectoLex WDG	73049-57	Valent BioSciences	Water dispersible granule	Larvae	Biorational
Bacillus sphaericus, (Bs)	VectoLex WSP	73049-20	Valent BioSciences	Water soluble packet	Larvae	Biorational
Bacillus thuringiensis var. israelensis (Bti)	VectoBac 12AS	73049-38	Valent BioSciences	Liquid	Larvae	Biorational
Bacillus thuringiensis var. israelensis (Bti)	VectoBac G	275-50 or 73049-10	Valent BioSciences	Granule	Larvae	Biorational
Bacillus thuringiensis var. israelensis (Bti)	VectoBac Tech. Powder	73049-13	Valent BioSciences	Technical poweder	Larvae	Biorational
Bacillus thuringiensis var. israelensis (Bti)	Aquabac 200G	62637-3	Becker Microbial	Granule	Larvae	Biorational
Bacillus thuringiensis var. israelensis (Bti)	Bactimos Briquets	6218-47	Summit	Donut-style-briquets	Larvae	Biorational
Bacillus thuringiensis var. israelensis (Bti)	Teknar HP-D	73049-404	Valent BioSciences	Liquid	Larvae	Biorational
Monomolecular film	Agnique MMF	2302-14	Henkel Corp.	Liquid	Larvae and pupae	Surface film
Petroleum oil	GB 1111	8329-72	Clarke	Liquid	Larvae and pupae	Surface film
Diflubenzuron	Dimilin 25W	400-465	Uniroyal Chemical	Wettable powder	Larvae	IGR
S-methoprene	Altosid ALL	2724-446	Wellmark-Zoecon	Liquid Concentrate	Larvae	IGR
S-methoprene	Altosid Briquets	2724-375	Wellmark-Zoecon	Briquet	Larvae	IGR
S-methoprene	Altosid Pellets	2724-448	Wellmark-Zoecon	Pellet-type granules	Larvae	IGR
S-methoprene	Altosid SBG	2724-489	Wellmark-Zoecon	Granule	Larvae	IGR
S-methoprene	Altosid XR-G	2724-451	Wellmark-Zoecon	Briquet	Larvae	IGR
Temephos	Abate 2-BG	8329-71	Clarke	Granule	Larvae	OP
Temephos	5% Skeeter Abate	8329-70	Clarke	Granule	Larvae	OP

PESTICIDES USED FOR ADULT MOSQUITO CONTROL IN CALIFORNIA

For updated information on specific products approved for use in California, please refer to the California Department of Pesticide Regulation website: http://www.cdpr.ca.gov/docs/label/labelque.htm

ADULTICIDES ACTIVE INGREDIENT	TRADE NAME	EPA REG #	MFG	FORMULATION	APPLICATION	PESTICIDE CLASSIFICATION
Chlorpyrifos	Mosquitomaster 412	8329-36	Clarke	Liquid	Adults	OP
Malathion	Fyfanon® ULV	4787-8	Cheminova	Liquid	Adults	OP
Naled	Dibrom® Concentrate	5481-480	AMVAC	Liquid	Adults	OP
Naled	Trumpet™ EC	5481-481	AMVAC	Liquid	Adults	OP
Cyfluthrin	Tempo Ultra SC	432-1363	Bayer	Liquid	Adults	Pyrethroid
Deltamethrin	Suspend® SC	432-763	Aventis	Liquid	Adults	Pyrethroid
Lambda-cyhalothrin	Demand CS	100-1066	Syngenta	Liquid	Adults	Pryethroid
Permethrin	Aqua-Reslin®	432-796	Aventis	Liquid	Adults	Pyrethroid
Permethrin	Biomist® 4+12 ULV	8329-34	Clarke	Liquid	Adults	Pyrethroid
Permethrin	Permanone® Ready-To-Use	432-1182	Aventis	Liquid	Adults	Pyrethroid
Pyrethrins	Pyranone® 25-5	432-1050	Aventis	Liquid	Adults	Pyrethroid
Pyrethrins	Pyrenone® Crop Spray	432-1033	Aventis	Liquid	Adults	Pyrethroid
Pyrethrins	Pyrocide® 7396	1021-1569	MGK	Liquid	Adults	Pyrethroid
Resmethrin	Scourge® Insecticide (4%)	432-716	Aventis	Liquid	Adults	Pyrethroid
Resmethrin	Scourge® Insecticide (18%)	432-667	Aventis	Liquid	Adults	Pyrethroid
Sumithrin	Anvil® 10+10 ULV	1021-1688-8329	Clarke	Liquid	Adults	Pyrethroid

APPENDIX G

HEALTH AND SAFETY CODES PERTINENT TO MOSQUITO CONTROL

In California, mosquito and vector control agencies are regulated by sections of the California Health and Safety (H&S) Code, Food and Agriculture Code, California Code of Regulations, and others. The following components of this appendix have been adapted from the Overview of Mosquito Control Practices in California, California Department of Public Health http://www.westnile.ca.gov/resources.php.

GOVERNING LAWS AND REGULATIONS

Many federal and state laws govern the activities of vector control agencies, including the Clean Water Act (CWA), the Endangered Species Act (ESA), and the Federal Insecticide Fungicide and Rodenticide Act (FIFRA). Pesticide application by vector control agencies in California is regulated under FIFRA. FIFRA is administered through the U.S. Environmental Protection Agency, and regulates the registration, labeling, and sales of pesticides in the United States.

Under the H&S Code, local vector control agencies have the authority to conduct surveillance for vectors, prevent the occurrence of vectors, and legally abate production of vectors or public nuisance defined as "Any water that is a breeding place for vectors" and "Any activity that supports the development, attraction, or harborage of vectors, or that facilitates the introduction or spread of vectors."(H&S Code Section 2002(j) and 2040). Vector control agencies also have authority to participate in review, comment, and make recommendations regarding local, state, or federal land use planning and environmental quality processes, documents, permits, licenses, and entitlements for projects and their potential effects with respect to vector production. (H&S Code Section 2041) Website link: http://caselaw.lp.findlaw.com/cacodes/hsc/2040-2055.html

Additionally, agencies have broad authority to influence landowners to reduce or "abate" the source of a vector problem. Actions may include imposing civil penalties of up to $1000 per day plus costs associated with controlling the vector. Agencies have authority to "abate" vector sources on private and publicly owned properties. (H&S Code Sections 2060-2065). Website link: http://caselaw.lp.findlaw.com/cacodes/hsc/2060-2067.html

Mosquito and vector control programs that enter into a cooperative agreement with the California Department of Public Health are exempted from some pesticide related laws under Title 3 of the California Code of Regulations Section 6620. Specifically, these agencies are exempted from "Consent to Apply" (Title 3, California Code of Regulations, Section 6616), "Notice" (Title 3, California Code of Regulations, Section 6618), and the "Protection of Persons, Animals, and Property" (Title 3, California Code of Regulations, Section 6614). Essentially, these provisions obviate the vector control agency from having to

notify or get permission from landowners prior to applying a pesticide to their property in the interest of preserving the public health. Website link: http://www.cdpr.ca.gov/docs/legbills/calcode/030201.html

A vector control technician working at a vector control agency must be a "certified technician" or work under the direct supervision of a "certified technician" to apply pesticides. Vector control technicians achieve certification through an examination process administered by the California Department of Public Health.

Vector control agencies cannot use any pesticide not registered for use in California, and are required to keep detailed records of each pesticide application, including date, location, and amount applied. All pesticides must be applied in accordance with the labeling of the product as registered with the U.S. EPA.

APPENDIX H

Additional Resources for Mosquito Control and Arbovirus Surveillance

WEBSITE	URL	AVAILABLE INFORMATION
California West Nile Virus Website	http://westnile.ca.gov	Up-to-date information on the spread of West Nile virus throughout California, personal protection measures, online dead bird reporting, bird identification charts, mosquito control information and links, clinician information, local agency information, public education materials.
UC Davis Center for Vectorborne Diseases	http://cvec.ucdavis.edu/	Frequently updated reports and interactive maps on arbovirus surveillance and mosquito occurrence in California.
Mosquito and Vector Control Association of California	http://www.mvcac.org	News, membership information, event calendars, and other topics of interest to California's mosquito control agencies.
American Mosquito Control Association	http://www.mosquito.org/	News and other topics of interest to national mosquito control and mosquito-borne disease information.
California Vectorborne Disease Surveillance Gateway	http://surv.mvcac.org	Data management system for California's mosquito control agencies.
California Data Exchange Center	http://cdec.water.ca.gov	Water-related data from the California Department of Water Resources, including historical and current stream flow, snow pack, and precipitation information.
UC IPM Online	http://www.ipm.ucdavis.edu	Precipitation and temperature data for stations throughout California; also allows calculation of degree-days based on user-defined data and parameters.
National Weather Service–Climate Prediction Center	http://www.cpc.ncep.noaa.gov/products/predictions/	Short-range (daily) to long-range (seasonal) temperature and precipitation forecasts. Also provides El Niño-related forecasts.
California Agricultural Statistics Service	http://www.nass.usda.gov/ca/	Crop acreage, yield, and production estimates for past years and the current year's projections. Reports for particular crops are published at specific times during the year–see the calendar on the website.
US Environmental Protection Agency –Mosquito Control	http://www.epa.gov/pesticides/health/mosquitoes/	Describes the role of mosquito control agencies and products used for mosquito control.
US Centers for Disease Control and Prevention–West Nile Virus	http://www.cdc.gov/ncidod/dvbid/westnile/index.htm	Information on the transmission of West Nile virus across the United States, viral ecology and background on WNV, and personal protection measures in various languages.
National Pesticide Telecommunications Network	http://npic.orst.edu/factsheets/DEETgen.pdf	Information regarding the use of DEET
National Pesticide Information Center	http://npic.orst.edu/	More information about using repellents

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH