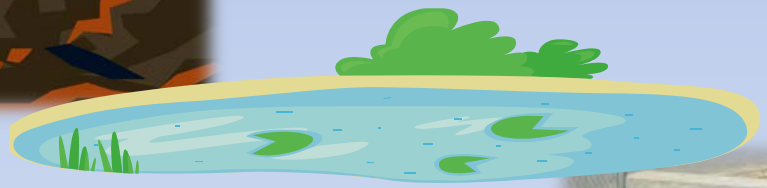
Physical Control of Mosquitoes



Chapter 7

Physical Control of Mosquitoes

Physical Control of Mosquitoes in Natural Sources

Physical Control of Urban Residential Sources

Physical Control of Mosquitoes from Agricultural Sources

Physical Control of Mosquitoes in Large Water Storage and Conveyance Structures

Physical Control of Mosquitoes

- Some of the earliest forms of mosquito abatement were examples of physical control. For example, the methods used to control mosquitoes that transmitted yellow fever **virus** and malaria parasites in Central America during the building of the Panama Canal were physical control methods. Physical control of mosquitoes essentially is the modification of the environment in a way that reduces the number of mosquito breeding sites.

- Physical control often is integrated with chemical or biological control in successful IPM programs. In some instances, physical control by itself is sufficient to effectively reduce mosquito populations. Examples of physical control measures include draining of a pond, grading of an agricultural field to eliminate pools of standing water, or conversion of a swamp to farmland. California mosquito control agencies employing earth moving equipment to eliminate troublesome mosquito sources have demonstrated that well designed projects can benefit agriculture, the environment, and mosquito control mutually.

Physical Control of Mosquitoes

- Physical control may be as simple as shutting off the flow of irrigation water at the optimum time to prevent standing water. Conversely, it may be complex, requiring a detailed plan. Major projects usually involve other agencies and require activities such as aerial surveys, filling, grading, and ditching. Maintenance requirements of projects after completion can include ditch clearing, repairing water gates, or restoration of dikes.

Examples of Physical Control Measures

- Agricultural fields with low spots that hold irrigation water can be leveled more accurately with inexpensive modern laser leveling systems. This prevents accumulation of irrigation pools where mosquito larvae may develop and enhances drainage of excess irrigation water.
- Marshes may be modified so that upland areas are periodically flushed with saline water, eliminating development of freshwater mosquito species.
- Artificial permanent or semi-permanent bodies of water may be kept mosquito free by modifying their banks to eliminate shallow regions with emergent vegetation where mosquito larvae can avoid predators.
- Engineered storm water structures for flood control and pollution mitigation can be designed and maintained to drain rapidly and completely to prevent mosquito production.
- Artificial structures for holding drainage water from highways may be designed in ways to avoid holding the water for periods long enough to permit completion of mosquito development. These structures are known as “Best Management Practices (BMP)” and research for better designs has been going on for several years between the California Department of Transportation and the California Department of Public Health.

Constraints to Physical Mosquito Control Measures

- In the early 20th century, there were few objections to the physical methods used to eliminate mosquito breeding.
- Currently, a variety of public agencies have statutory regulatory responsibilities for water-related ecosystems these include streams, rivers, lakes, marshes, vernal pools, and neglected storm water storage and conveyance systems. Some of these agencies include the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and various state agencies.
- Mosquito control agencies now prepare plans in advance annually for any work planned involving mosquito control in waters under jurisdiction of the aforementioned resource agencies for their review and approval.

Physical Control of Urban Residential Sources

- Urban residential sources of mosquito breeding include ornamental ponds, neglected swimming pools and spas, runoff pools from over-irrigated landscape or leaking plumbing, clogged rain gutters, and faulty septic systems, Finding mosquito sources in residential areas requires intensive and frequent inspections. Swimming pools in unoccupied residences has become a particularly difficult problem for mosquito control programs.
- The species of mosquitoes that often emanate from these kinds of sources are also **vectors** of serious disease organisms such as WNV and SLE.
- The usual physical control methods that must be employed to solve urban residential mosquito problems involve maintenance, repair, and proper water management. The question of who will pay for these actions often leads to legal response.

Physical Control of Mosquitoes from Community, Commercial and Industrial Sources

- Large industrial facilities may have various types of holding ponds and other facilities for handling of liquid waste from manufacturing or processing activities.

- The usual involvement for mosquito abatement district personnel is to monitor and identify mosquito problems, and to advise the management on ways to eliminate the problem. Most commercial managers strive to be good public citizens, especially when their facilities are close to population centers.

- Publicly-owned facilities that may cause mosquito problems include gutters, catch basins, and culverts associated with public streets , community sewage disposal facilities, and public lakes and reservoirs.

Physical Control of Mosquitoes from Community, Commercial and Industrial Sources

- Some of the design features of drainage structures that tend to minimize mosquito breeding are:
  - Are free of small coves
  - Are large enough for wind to cause wave action
  - Are deep enough to discourage growth of emergent vegetation
  - Have steep inner levee faces to limit growth of shoreline vegetation
  - Are not loaded with organic wastes in the form of floating solids or vegetation
  - Are well maintained

Physical Control of Mosquitoes from Community, Commercial and Industrial Sources

- Mosquitoes associated with street and road structures for the capture and conveyance of storm-water and water from melted snow traditionally have been one of the biggest challenges for local agencies. Chemical control methods are expensive, tedious, and short-lived.
- Strategies have been adopted, including steep channels that cause flushing of immature mosquitoes.
- Since the early 2000's, all new construction (i.e., commercial and industrial buildings and residential housing tracts) must comply with federal and state clean water laws that mandate the proper management of storm-water and urban runoff.
- Mosquito control programs will need to become familiar with the structure and function of different storm-water systems and forge relationships with the local planning agency to obtain details of location.

Physical Control of Mosquitoes in Natural Sources

- Prior to the extensive water resource projects and land developments which now characterize California, mosquito problems mainly were related to natural sources such as swamps, marshes, river flood plains, and vernal pools.
- Fortunately, natural sources of water do not present as many mosquito problems as do artificial sources. This is because natural sources often contain fish and other mosquito predators, have free-flowing water not conducive to mosquito development, and often do not represent a rich source of food for mosquito larvae. However, there are notable exceptions this, such as river flood plains and flooded tree holes.
- Where significant problems with mosquitoes do occur in natural wetlands, solutions are usually complicated and arrived at only after considerable coordination with the various local and regional agencies having jurisdiction of some kind.

Salt Marshes

- Marshes are wetlands that are subject to frequent or continuous flooding. They are similar to swamps, but differ in that swamps are usually characterized by woody vegetation (e.g., mangrove swamps) whereas marshes typically feature grasses, rushes, reeds, typhas, sedges, and other herbaceous plants.

A coastal salt marsh with water flow restricted by trash.

- Salt marshes represent a special type of marsh that is found along coasts of oceans and bays in the intertidal zone between land and the sea. Salt marshes are usually associated with estuaries or bays, which in turn have shores consisting of mudflats and sandflats.

- Typical animals include mosquitoes such as *Aedes squamiger* and *Ae. dorsalis*. Because these species are aggressive human biters, salt marshes are of great concern to coastal mosquito abatement agencies. The challenge to mosquito abatement agencies is to address mosquito problems in ways that preserve the valuable characteristics of the marsh ecosystem while minimizing the production of biting mosquitoes.

Open Circulation Marshes

- It has been known for many years that ditching of salt marshes to increase tidal circulation helps reduce mosquito populations. Studies have shown that the increased tidal flushing increases fish diversity and density by improving fish access from tidal channels. This has a negative impact on mosquito populations through predation by fish, but a positive impact on other animals such as salt marsh song sparrows.

- Although ecologists often prefer to rely on natural marsh channels for tidal flushing, most recognize that well-planned ditching is preferable to application of insecticides for mosquito control.

Restricted Circulation Marshes

- When tidewater circulation is restricted due to a low **tidal prism** (=tidal volume) ditching may not be effective in reducing larval mosquito populations. Low tidal prisms may be due to artificial marsh obstructions such as roads, berms, inoperative tidal gates, or plugged culverts, or to natural deficiencies in water courses.

- In many cases, mosquito control may be achieved by removing restrictions: repairing tide gates, clearing existing or installing larger culverts, and installing new ditches to supplement natural water courses.

Impoundments

- Impoundments are areas in a salt marsh created by construction of earthen dikes that allow the areas to be artificially flooded during the mosquito breeding season. Most salt marsh mosquitoes will not lay their eggs upon standing water. Instead, they oviposit upon moist soil; and the eggs hatch when flooded by tides or rainfall. Thus impoundments may eliminate mosquito production from the area without having to use pesticides.

- Impoundments were once used extensively for mosquito control, but are seldom used today. The construction of dikes and the installation of maintenance structures are more expensive than managing marsh circulation, and marsh ecologists object to the significant changes in marsh flora and fauna that often accompany impounding.

Modern Marsh Management

- In the late 1800s and early 1900s, thousands of acres of salt marsh in California were converted to other types of land use though draining and filling. This was before the valuable role of salt marshes in the ecosystem was appreciated. Now, the emphasis is on comprehensive management of salt marshes in ways that meet multiple goals, including mosquito abatement.

- Federal, state and local legislation dictates that each proposed management activity meet standards for careful engineering and biological surveys and that the impact upon the environment be assessed before projects are undertaken.

Physical Control of Mosquitoes from Agricultural Sources

- The primary mosquito production problems of agricultural areas result during the application of irrigation water to crops and the drainage and storage of waste water.

- Mosquito problems may arise with both large scale operations and small family farms. Generally, mosquito production in agricultural operations are most pronounced in areas where crops are irrigated. However, even in dry-farming areas, problems can be created in connection with stock ponds, waste water ponds, and other water-holding activities.

Physical Control of Mosquitoes from Agricultural Sources

- The degree to which irrigation and drainage contribute to mosquito problems depends upon a number of factors. These factors include:

- Soil type and characteristics / Type of crop
- Water quality / Crop water requirements
- Ground slope / Management of intercrop periods
- Farm irrigation delivery and control systems / Water table
- Irrigation methods / Subsurface and surface drainage
- Soil intake rates (permeability) / Soil fertility
- Soil compaction / Soil sealing (bacterial, sedimentation)
- Presence of hardpan / Soil chemistry
- Cultivation practices / Soil temperature ranges

Physical Control of Mosquitoes from Agricultural Sources

- Proper drainage of excess surface water is essential to the prevention of mosquito problems. Even if draining practices are sound, it is necessary to maintain ditches and other structures for conveyance of drainage water in good order to prevent ponding sufficient to allow development of mosquitoes.

- Proper drainage of surface water depends on properly terraced and graded fields. This has become easier and more efficient with the advent of laser leveling systems

Flooded Agricultural Crops

- Rice fields and irrigated pastures are two crops that present enormous challenges to mosquito control agencies because both often involve flooding with irrigation water for long periods.
- Mosquitofish may come in with the irrigation water or may be added by mosquito control agencies, but they rarely distribute to all parts of the fields unless present in large numbers.

- The first irrigation of the season typically results in a generation of *Aedes* mosquitoes that develops rapidly in the absence of predators. Subsequently, *Culex* and *Anopheles* mosquitoes lay eggs and replace the emerged *Aedes*.
- Many physical methods have been used to reduce the numbers of mosquitoes produced in these crops. Timing of flooding is probably the most effective. Sometimes delay in flooding in just a week or so can make a profound difference in mosquito development.

Intermittently Irrigated Crops

- Mosquito breeding in crops that are furrow or sprinkler irrigated can also produce mosquitoes. Alfalfa, cotton, corn, orchards, vineyards and date groves are among irrigated crops that frequently cause problems.
- Listed are some recommendations employed in applicable situations to improve irrigation water management and reduce mosquito production. These have been summarized from the recommendations of the Soil Conservation Service.

- Re-grade fields to proper slopes of 0.1-0.3 foot per 100 feet and eliminate irrigation grade reversals causing water to pond.
- Continue the slope to the end of the strip by eliminating the level section at the end of the irrigation run
- Reorganize irrigation systems allowing better control of water.
- Change method/direction of irrigation.
- Adjust delivery based on soil intake rate and length of run.
- Apply soil amendments
- Select the proper plants for the soil.
- Rotate grazing and eliminate cultivation or grazing of fields when they are wet.

Physical Control of Mosquitoes in Large Water Storage and Conveyance Structures

- As of 2014, California had over 1,400 dams and 1,300 named reservoirs with a maximum storage capacity of more than 38 million acre feet of water, of which 80% was used for irrigation.
- Reservoirs and their conveyance structures can be important sources of mosquitoes. However, large reservoirs and their associated concrete-lined ditches rarely present mosquito problems because standards of maintenance are usually very high, and the usual situations that promote mosquito breeding (clogged ditches, shorelines with emergent vegetation, etc.) usually are not present.
- Older dams and reservoirs can present problems with mosquitoes because of general aging and gradual deterioration of concrete surfaces.
- Reservoirs are filled each winter and spring as the runoff from higher land occurs and drawn upon later during summer and autumn. The area of drawdown around the margins of the reservoir between the surface elevations of maximum and minimum storage is called the zone of fluctuation. Where low areas in this zone retain water as the surface elevation is lowered, mosquitoes can breed unless cuts are made in the low ends of the depressions to make them self-draining.

Future Trends in Physical Control

- It is safe to say that there will ever be a return to the days of wholesale destruction of wetlands in California or elsewhere. This is true of cases where the destruction was for the purpose of highway construction, creation of housing tracts, and other developments, and it is also true in the case of physical control for mosquito abatement. Federal and state laws now regulate changes that are permitted in wetlands, and even small projects require environmental impact assessments and review by a number of agencies and interested individual citizens.

- Another likely trend will be a continual reduction in the role of insecticides in mosquito control in wetlands. Accompanying this trend will be greater emphasis on wetlands management for mosquito abatement, which is simply modern physical control.

Biological Control of Mosquitoes

Chapter 8

Biological Control of Mosquitoes

Biological Control by Introduction of Natural Enemies

Microbial Organisms for Mosquito Control

Autocidal Control

Genetic Control

Biological Control of Mosquitoes

- Biological Control (BC) is the use of natural enemies to manage mosquito populations. There are several types of biological control including the direct introduction of parasites, pathogens, and predators to target mosquitoes.

Biological Control of Mosquitoes

- These introductions are of two types:
  - Inoculative, are single small introductions of natural enemies, followed by their semi-permanent establishment in the environment.
  - Inundative, are multiple releases of large numbers (often millions of individuals). In most field trials inundative releases have been more successful than inoculative ones.

Biological Control of Mosquitoes

- Microbial pathogens of mosquitoes include viruses, bacteria, fungi, protozoa, nematodes, and microsporidia.
- Biological mosquito control techniques has almost been totally directed at larvae.

Infecting Cx. quinquefasciatus with parasitic nematodes

- The management of habitats to conserve natural enemies of mosquitoes is important in mosquito control operations.
- With an expanded definition of BC to include toxins of microorganisms we can include the insecticide *Bacillus thuringiensis israelensis (Bti)* which can be both a BC and a biorational insecticide.

Biological Control by Introduction of Natural Enemies

- The most commonly-used species is *Gambusia affinis* (mosquitofish). This species is the most widely distributed fish worldwide for mosquito control. Carp and minnows have been effectively used as well.
- *Gambusia affinis* is not native to California, its natural geographic distribution is the south eastern USA. This species cannot survive the winter in many colder areas and must be re-introduced to mosquito habitats.
- *Gambusia affinis* has been used with great success against mosquitoes that breed in swimming pools, bird baths, and similar artificial water structures.
- Some mosquito abatement districts have developed large-scale rearing facilities for mosquitofish, but it needs to be remembered that they are not a native fish to California and their use is discouraged in some open water areas because they tend to attack young individuals of native fish species.

Microbial Organisms for Mosquito Control

- Microbial organisms *Bacillus thuringiensis israelensis* (Bti) and *Bacillus sphaericus* (Bs) contain characteristics of both microbial and BC agents

- Bti kills mosquito larvae when they ingest crystalline toxins produced by the bacteria. The toxin interferes with the larvae's digestion. Bs also produces toxins, the mosquito larvae can suffer lethal effects from the infection.

Other Organisms Tested as BC Agents Against Mosquitoes

- Copepods, fungi (genus *Coelomomyces*), *Lagenidium* have been studied as BC agents against mosquitoes.
- Other organisms that are studied are mermethid nematodes (parasitic roundworms), planaria, and tadpole shrimp.
- Some California mosquito abatement districts with well established biological control programs do have successful operations for a few of these agents.

Autocidal Control

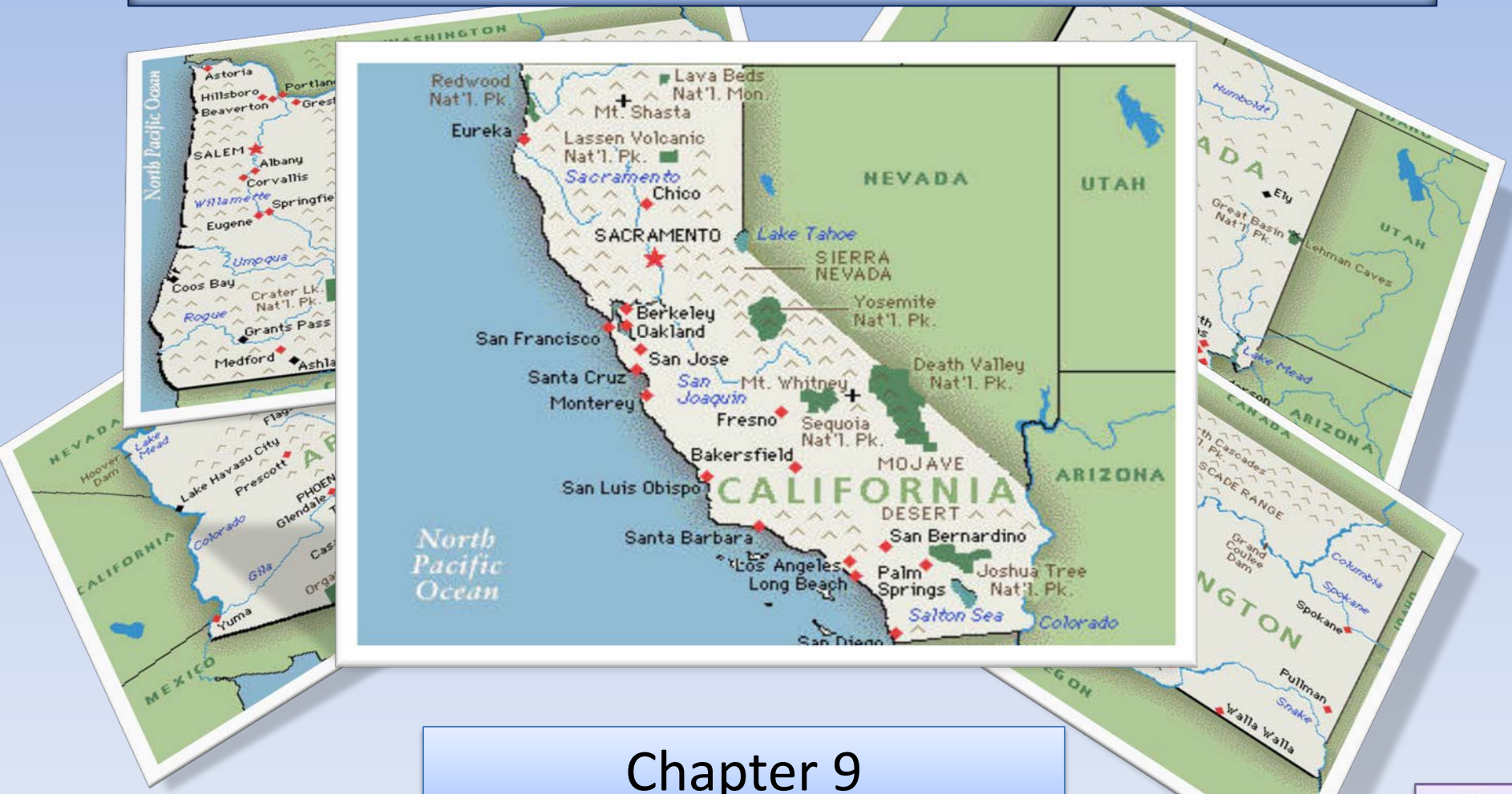
- Autocidal, means by which an organism kills or harms themselves.
- Related to pest control it means a way where sterile or genetically altered insects of a species is released to reduce the breeding success of a particular population.
- How autocidal control is carried out involves the rearing of large numbers of male insects, followed by their sterilization by means of either radiation or chemicals. Once sterilized these males are released to mate with the wild females resulting in a lack of fertile offspring.
- Over time and repeated releases of the sterile males the natural (wild) population would decrease.

Genetic Control

- The autocidal design used to sterilize male pest insects are not considered genetic methods because there is not a change in the genes of the wild populations.

- In the area of genetics presently there is a active and exciting area of research for the future in not just mosquitoes but other arthropod vectors as well.

Mosquito Control in California



Chapter 9

Principal California Agencies Involved with Mosquitoes

Approaches to Mosquito Control in California

The Future of Mosquito Control in California

Principal California Agencies Involved with Mosquitoes

- Mosquito control in California is carried out by more than 70 local agencies, including mosquito and **vector** control districts, environmental health departments, and county health departments.
- About 66 of these agencies are members of the Mosquito and Vector Control Association of California (MVCAC).
- The objective of MVCAC is to promote cooperation among agencies and personnel involved in mosquito control and related subjects, to stimulate improved mosquito control methods, and to disseminate information about mosquito control.

Principal California Agencies Involved with Mosquitoes

- State organizations cooperate closely with local agencies conducting mosquito control. The California Department of Public Health (CDPH) provides many services to local agencies and to the public in connection with mosquito problems.

- Some of their activities include provision of technical support to agencies on mosquito control operations, testing and certification of public health pesticide applicators, coordination of a statewide mosquito-borne arbovirus disease surveillance program, performance of epidemiological investigations of human disease cases associated with mosquitoes, and coordination and participation in a regional emergency response in conjunction with the California Office of Emergency Services.

Principal California Agencies Involved with Mosquitoes

The Cooperative Agreement, is an agreement between CDPH and local agencies that agree to certain standards of operation whereby CDPH assumes responsibility for certain functions pertaining to the application of state laws and regulations pertaining to pesticide use for vector control by the districts.

Cooperating agencies agree to calibrate pesticide application equipment, maintain records of pesticide applications, submit pesticide applications and adverse pesticide application effects reports to the County Agricultural Commissioners, certify pesticide applicators, and submit to periodic inspections to insure agency activities are in compliance with state laws and regulations pertaining to pesticide use.

Principal California Agencies Involved with Mosquitoes

- The University of California (UC) also participates in mosquito-orientated activities. UC provides education in subjects related to medical entomology and vector biology, and many of these subjects have considerable content related to the biology and control of mosquitoes. UC also has the responsibility for research and development in mosquito biology and control. UC cooperated closely with CDPH and MVCAC in their research and development programs.

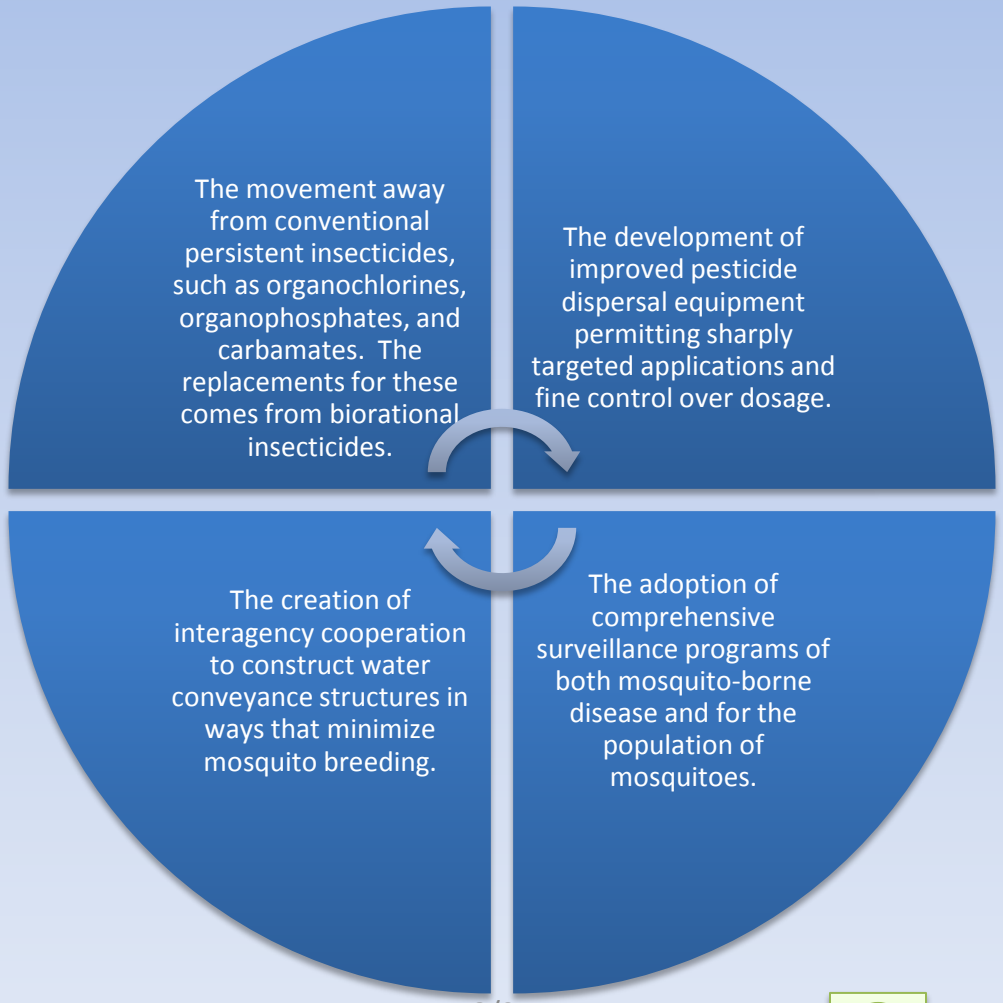
Approaches to Mosquito Control in California

- The basic approach to mosquito control in California is the control of mosquito larvae. This is accomplished through physical, biological, and chemical control methods.

- Mosquito control in California now is vastly safer and environmentally friendlier than it was just 50 to 60 years ago.

Approaches to Mosquito Control in California

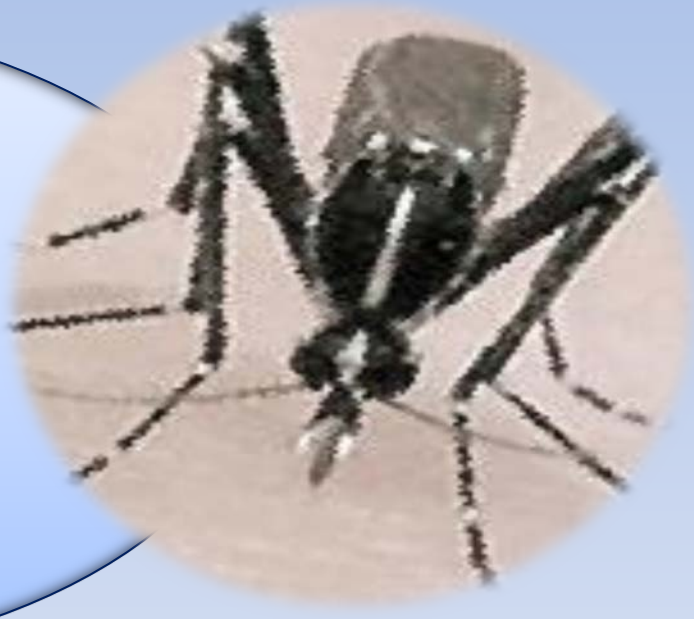
The most important improvements to mosquito control in California are due to…..

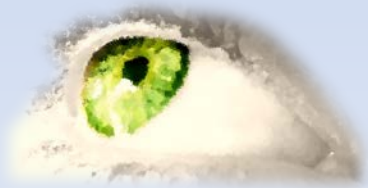


The Future of Mosquito Control in California

- Mosquitoes will continue to be a problem for the people of California.
- The emphasis on biorational insecticides to control mosquitoes will continue.
- The major responsibility of mosquito technicians will continue to be as an educator to the public about mosquito control procedures and to help the public to understand the difference between conventional and biorational materials.
- The demand for training and certification of pesticide technicians will be continued and strengthened along with the advancements in mosquito control technology.

Surveillance for Mosquitoes and Mosquito-borne Diseases





Surveillance for Mosquitoes and Mosquito-Borne Diseases

Mosquito Abundance

Mosquito Infections

Avian Infections

Additional Infections

Human Infections

Risk Assessment and Response Levels

Surveillance for insecticide resistance by mosquitoes

Reporting and Dissemination of Surveillance Results

Surveillance for Mosquitoes and Mosquito-Borne Diseases

- Arboviruses
  - Surveillance for both human and equine diseases caused by infection with mosquito-borne arboviruses has been carried out in California for more than 80 years. Surveillance has been expanded to include arboviral infection in wild and sentinel vertebrates, and in wild caught mosquitoes.
  - The CDPH, UC, and the 60+ mosquito abatement agencies have a cooperative venture each managing a portion of surveillance activities.
  - CDPH, manages the program reporting of results, and testing of surveillance samples
  - UC, conducts research on new surveillance testing and reporting methodology.
  - Mosquito abatement agencies, collect biological sampling for testing.

Surveillance for Mosquitoes and Mosquito-Borne Diseases

- Before 2000, the primary focus of the surveillance program was the two most important arboviruses in the state, WEE and SLE. The detection of WNV in New York in 1999 prompted a review and expansion of surveillance guidelines in California, and consequently, when WNV arrived in California in 2003, state agencies were well-prepared for its detection and monitoring.

Surveillance for Mosquitoes and Mosquito-Borne Diseases

The current surveillance plan is described completely in the "California Mosquito-borne Virus Surveillance and Response Plan" published by CDPH, UC and MVCAC.

An additional surveillance and response plan "Operational Plan for Emergency Response to Mosquito-borne Disease Outbreaks".

Analysis of Climate Variation

- Disease ecologists have observed that various weather factors tend to presage peaks of arboviral activity in North America.
- The work conducted by many individuals and agencies in California has advanced useful predictive models for arboviral activity based on climate forecasts.

Mosquito Abundance

- Mosquito abundance can be estimated by sampling larval and adult mosquitoes. This information helps abatement agencies with deciding what types of control activities should be taken.
- Mosquito larvae are sampled by use of a long-handled ladle called a “dipper”. Technicians sample small bodies of water and count the number of larvae appearing in the dipper as well as the number of dips.
- High number of larvae do not always equal high numbers of adults because of mortality factors.

Mosquito Abundance

- Guidelines for adult mosquito surveillance are contained in the publication “Integrated Mosquito Surveillance Guidelines”
- Several methods are used to estimate adult abundance. The most common and oldest method is the New Jersey light trap. The trap needs a 110V power source, but little attention is needed after it is installed. For the estimation of Mosquito abundance is a nightly count of captured mosquitoes broken-down by species.

Example:
10 traps were operated for 5 night each, and the total number trapped was 73,234 and 23,678.
Cx. tarsalis: 73,234/10 X 5=
1,465 female per night.
Ae. melanimom: 23,678/10 X 5=
474 females per night

Mosquito Abundance

- Carbon-dioxide traps are used for both estimates of adult mosquito abundance and for collection of female mosquitoes for virus testing.
- Carbon-dioxide (dry ice) baited traps are small, light, battery powered, and portable.

Mosquito Abundance

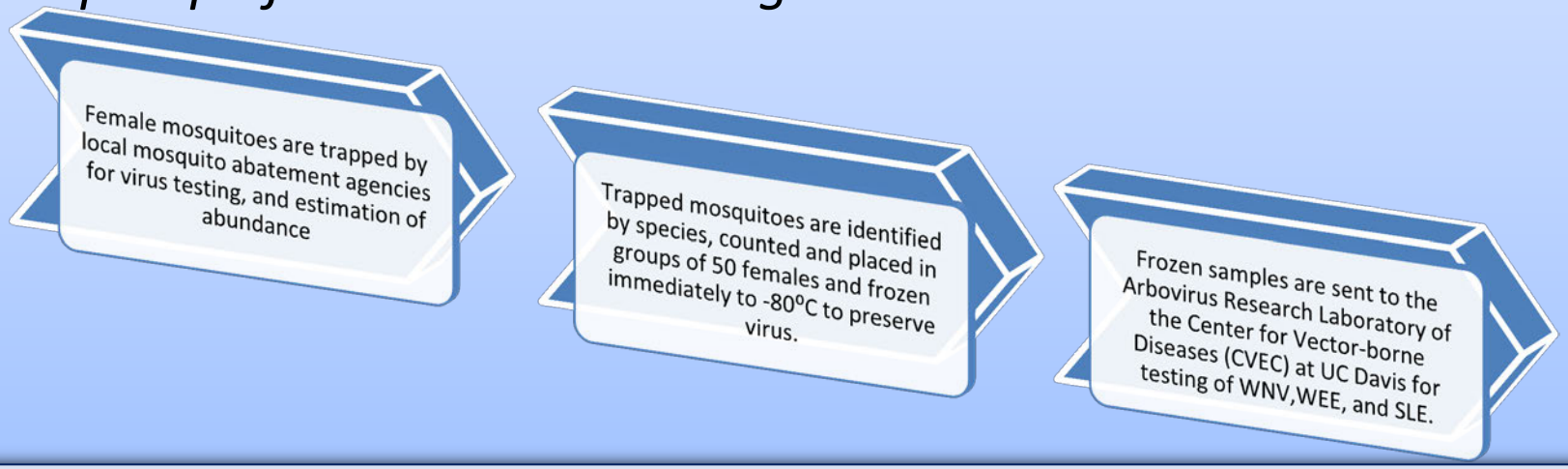
- Gravid females of some species of mosquitos, such as *Culex* can be attracted to traps containing mixtures of oviposition stimulants like the extracts of rotten hay or grass. Female mosquitoes enter the trap and are forces into collection containers by a updraft fan.

Mosquito Abundance

- Another way to estimate female mosquito abundance is a “resting box”. These are painted dark saturated colors like red, it is thought that the box looks like a dark hiding spot for the female mosquitoes with the color allowing technicians to be able to see the mosquitoes. Technicians remove the mosquitoes with a mouth aspirator.

Mosquito Infections

- Early virus activity can be detected by testing adult female mosquitoes for viral infection.
- Since *Culex tarsalis* is the vector for WEE, SLE, AND WNV, the arbovirus surveillance program points its testing to this species. Other important species are *Culex pipiens*, *Cx. quinquefasciatus* and *Cx. stigmatosoma*.



Avian Infections

- There are three ways avian populations can be tested for evidence of arboviral infections.
  - The use of flocks of chickens maintained in cages as sentinels to detect arboviral antibodies.
  - The collection and bleeding of wild birds to detect arboviral antibodies.
  - The testing of dead birds for virus reported by the public in connection with the CDPH WNV Dead Bird Program.

Avian Infections
Sentinel Chickens

- In California, flocks of ten chickens are placed in locations where mosquitoes are known to be abundant, or where there is a history of arboviral activity.
- Technicians of local mosquitoes abatement agencies collect blood samples every two weeks by pricking the comb and allowing a drop of blood to flow onto a filter paper strip. The strip is dried and mailed for testing to the Richmond Lab of Vector-borne Disease Section of CDPH.
- Chickens infected by mosquitoes with arboviruses develop antibodies that are detected when testing. The term is seroconverted when the chickens are positive

- Mosquito-borne virus activity can be tracked by following patterns of seroconversion in sentinel chickens.

Avian Infections

- Live birds
  - Viral infections in wild bird populations can be monitored by capturing, bleeding, and releasing birds in traps or mist nets and testing their blood for signs of infection.
- Deadbirds
  - WNV, in North America frequently causes death in some species of birds, especially ones in the *Corvidae* family such as crows, magpies, and jays.

Avian Infections

- In 2000, the CDPH began a surveillance program for members of the public to report dead birds.
- The program is based on the reporting of dead birds by members of the public through a Dead Bird Hotline (1-877-WNV-BIRD) and via the West Nile website (http://westnile.ca.gov).
- Birds meeting certain criteria are collected by local agencies. Local agencies swab the bird's oral cavity (following appropriate safety precautions), and press the sample onto an RNAse card. The cards are sent to the Arbovirus Research Laboratory of CVEC, where they are tested for WNV RNA (ribonucleic acid) using RT-PCR. Oral swabs from dead corvids are tested by some local agencies using rapid antigen tests; some agencies test dead birds "in-house" using RT-PCR.

Additional Infections

- In 2004, tree squirrels were added to the surveillance program, based on the fact they too are susceptible to fatal infections. However, squirrels were deleted from the surveillance program in 2014.
- Equine disease by WEE and WNV is not a good indicator if activity for these viruses because of the intentional or natural vaccination of horses, donkeys and mules. If cases are confirmed it is a sign that activity has amplified to levels where human cases are eminent.

Human Infections

- Local mosquito abatement agencies depend upon the rapid detection, confirmation, and reporting of human arbovirus cases to plan and implement emergency control activities to prevent further infections.

- Human cases are not a sensitive surveillance indicator of arboviral activity because most infected humans are asymptomatic.

Risk Assessment and Response Levels

- The California Mosquito-borne Virus Surveillance and Response Plan contains risk assessment guidelines based on values assigned to different levels of the surveillance components described above. These levels are evaluated annually by agencies cooperating in arbovirus surveillance. The entire plan can be downloaded in PDF format from the California West Nile virus website http://westnile.ca.gov.

WEE Surveillance Factor	Assessment Value	Benchmark
Adult Culex tarsalis abundance Determined by trapping adults, identifying them to species, and comparing numbers to averages previously documented for an area for current time period.	1	Cx. tarsalis abundance well below average(≤50%)
	2	Cx. tarsalis abundance below average (51-90%)
	3	Cx. tarsalis abundance average (91-150%)
	4	Cx. tarsalis abundance above average (151-300%)
	5	Cx. tarsalis abundance well above average(>300%)

Mosquito-borne Virus Risk Assessment for WEE based on adult *Culex tarsalis* abundance

Risk Assessment and Response Levels

- Malaria
  - Before World War II, malaria was endemic in parts of California, especially the Central Valley. Malaria is no longer endemic here, and very few human malaria cases occur as a result of being bitten by infected anopheline mosquitoes in the state. When this does happen, such cases are called "locally-transmitted malaria". However, several hundred cases of malaria are reported in California every year. Most of these are called "imported malaria", because the person is infected in a malarious area elsewhere in the world, and comes down with malaria after his or return to California.
  - These cases are tracked carefully by the CDPH, and when evidence suggests that a rare instance of imported malaria has occurred, the cases are investigated thoroughly by epidemiologists. This type of surveillance is called passive surveillance.

- Filariasis
  - There is no systematic surveillance for canine filariasis (dog heartworm), although researchers have done surveys for infections in dogs and other susceptible vertebrates from time to time. Some studies have been done to incriminate various mosquito species as vectors, but such studies are not done routinely in California.

Surveillance for insecticide resistance by mosquitoes

- Individual mosquito abatement agencies test populations of important species of mosquitoes for evidence of insecticide resistance, there is presently no statewide surveillance program for this purpose.
- A surveillance program for insecticide resistance by mosquitoes will require standardization of testing methods, establishment of a central testing laboratory or training of local agency personnel for testing, a method, a means of collecting and analyzing test results on a statewide basis, and means of periodic dissemination of test summaries mosquito abatement district personnel and other public health agencies.

Reporting and Dissemination of Surveillance Results

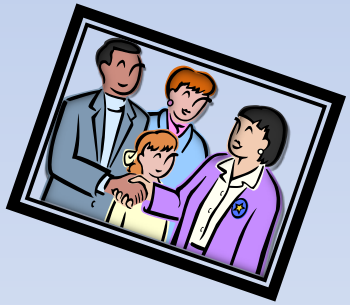
- **CalSurv**
  - CalSurv stands for California Vector-borne Disease Surveillance System, a cooperative program of the CDPH, MVCAC, and UC. It is a method for the collection of surveillance data and reporting of results for all vector-borne diseases, particularly for important diseases such as Lyme disease, Rocky Mountain spotted fever, and plague that heretofore have not had standardized surveillance systems comparable to the arbovirus disease surveillance system.
  - The CalSurv website is intended primarily for conveying vector-borne disease surveillance information to the general public. The website is based on a content management system, which is a system of software that allows for the assignment of content management to many specialists using access via the Internet. It is organized primarily along groups of vectors, but the menus are cross referenced by vectors, diseases, and pathogens, making access easier for the public for specific information categories.

Reporting and Dissemination of Surveillance Results

- **California Vector-borne Disease Surveillance Gateway**
  - The gateway provides a complete management system for surveillance activities by local agencies. As an example, a user may register and track sentinel chicken flocks, print specimen labels, and reports, and do all the other things concerning maintenance of chicken flock data management that previously had to be done by hand. It also provides for the reporting of mosquito abundance reports and shipping of mosquito pools for testing.
  - Using this system, individual agencies can maintain multi-year surveillance data that can be downloaded to agency computers in bulk. It also provides for data sharing among local agencies, state entities, and federal bodies. In addition, full mapping and analytical tools for analysis of multiyear data, including the calculation of risk response levels based on the scheme described above, are provided.
  - The services provided by this website are available only to registered users.

Public Relations in Mosquito Control

GOOD PUBLIC RELATIONS ARE AN ESSENTIAL PORTION OF ALL MOSQUITO CONTROL PROGRAMS.



Chapter 11

Public Relations in Mosquito Control

Types of Public Relations

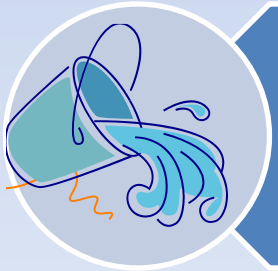
Public Relations Objectives

Public Relations Approaches

Public Relations in Mosquito Control

Mosquito control personnel must deal with people even more effectively than they deal with mosquitoes. If the public is to cooperate with and support our programs, they must understand what we are doing and why.

The more the public understands a mosquito control agency's efforts, the more cooperation and support the program will receive.



The best form of mosquito control is having the public know how not to raise mosquitoes and having them actively participating in monitoring their own properties for potential breeding sources.

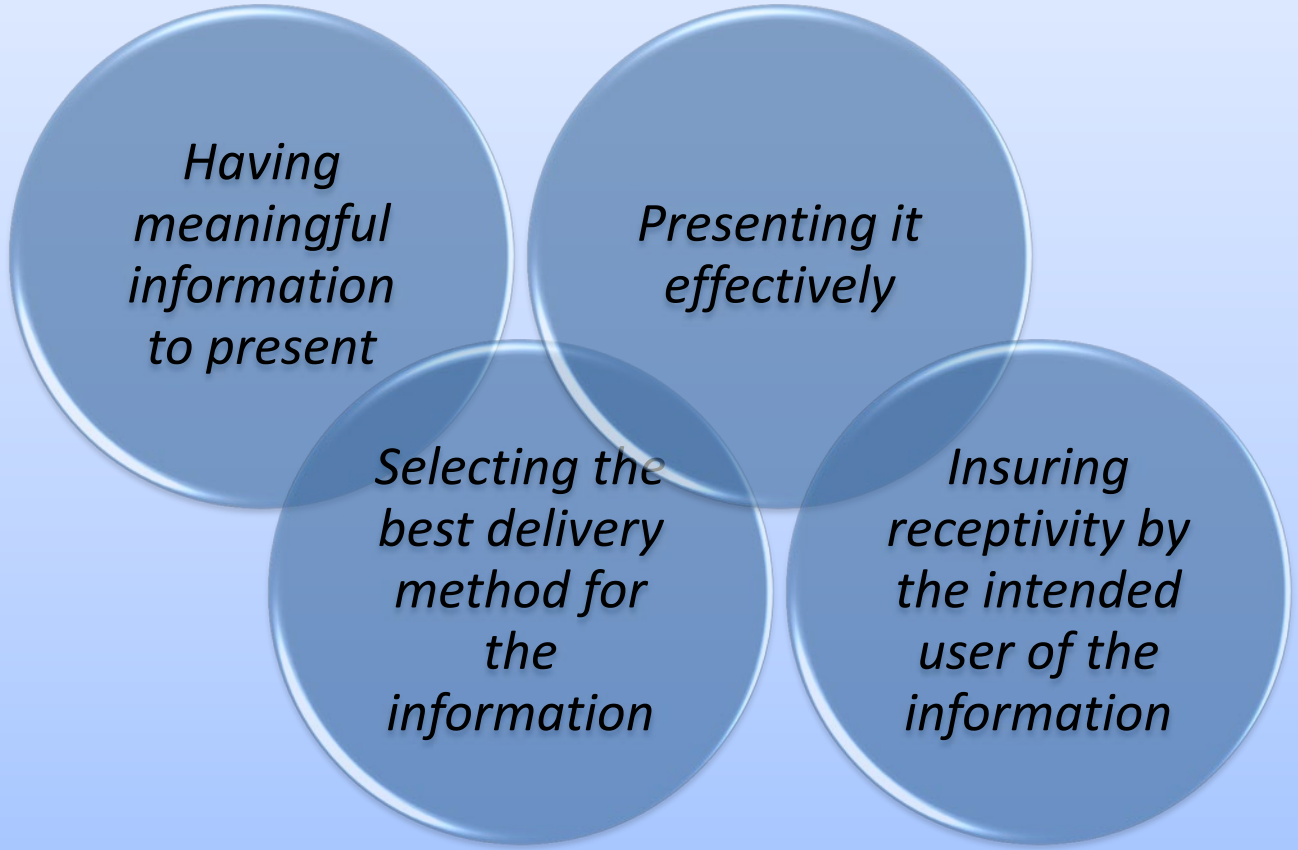
Types of Public Relations

- Person-to-person
  - *Service requests*
  - *Telephone calls*
  - *Letters*
- Group contacts
  - *Presentations*
  - *Tours*
  - *Committee work*
  - *School visits*

- Public official contacts
  - *Local and state legislators made aware of your program*
- Mass media activities
  - *Television*
  - *Radio*
  - *Newspapers*
  - *Websites*
  - *Exhibits*

Public Relations Objectives

A successful public relations program consists of:



Public Relations Approaches

- Although the average field technician will not have the responsibilities or opportunities to engage in all types of public relations activity on a daily basis, the activities and behavior of the technician in the field are the most important part of any agency's public relation efforts.

- You represent your mosquito control program. Your level of knowledge and professionalism will leave a lasting impression with the public, for better or for worse.

Public Relations Approaches

- It will take time, energy, and effort to create a effective program. I can be accomplished whether a small one-person operation or a large fully-staffed organization.
- What needs to be addressed is by what means you will use and whether your media approaches will be controlled or uncontrolled.
- Uncontrolled media channels means of public service announcements, press releases, radio and the benefit of these are that they offer the opportunity to reach the largest audiences.
- Controlled media channels are those in which you as the information provider has some control over the content of messages you convey to your audience and what messages they receive.

Public Relations Approaches

Uncontrolled

- Public Service Announcements
- Press releases
- Newspapers
- Radio

Controlled

- Websites
- Bookmarks
- Brochures
- Information fact sheets
- Periodic newsletters
- Fair exhibits
- Presentations to students and civil groups

Appendix 1
Glossary

Many of the words defined here have additional meanings.

The definitions given here are related to pests, insecticides, and pest management.

Glossary

- A
  - Active ingredient —, is the component of insecticides formulation that kills or controls pests. The chemical that is responsible for the toxic effects in a formulation.
  - Acre —, a land area of 43,560 square feet; equal to an area of 440 ft. long by 99ft. wide. Approximately equal to a sq. area 209 by 209 ft. Rectangle, 436 by 100ft. Metric equivalent is 0.405 hectares.
  - Aestivation —, the survival of mosquitoes during hot summer periods.
  - Anal papillae —, the soft fleshy lobes found on the anal segment of mosquito larvae. These lobes are associated with the physiological regulation of water balance in larvae. Species adapted to saline habitats have very small papillae to avoid excess loss of water; fresh water species have large papillae to avoid excess uptake of water.
  - Antenna —, one of the paired sense organs in the heads on insects.
  - Apical —, refers to the apex or the position opposite to the base of an insect structure.
  - Arbovirus —, any virus that is associated with an arthropod. Most are transmitted to vertebrate animals by arthropods.
  - Autogenous —, mosquitoes that demonstrate the trait of Autogeny.
  - Autogeny —, the production of viable eggs by mosquitoes and other blood-sucking insects without the necessity of a blood meal.

Glossary

- B
  - Bacteria —, a group of single-celled microorganisms. Some are pathogens (disease causing),but most are providing necessary functions in the environment.
  - Basal —, refers to the base, or the position opposite to the apex of a insect structure.
  - Binomial nomenclature —, is a system for naming biological organisms where each type of organism is given a name consisting of a genus and species.
  - Biological control —, the use of natural enemies to manage pest populations, including mosquitoes. It is also called biocontrol, for short.
  - Biopesticides —, are another term applied to biorational pesticide and insecticides.

- B
  - Biorational insecticides —, insecticides derived from natural materials such as animals, plants, bacteria, and some minerals. The EPA recognized three categories of biorational insecticides:
    1. Microbial insecticides
    2. Plant-incorporated protectants
    3. Biochemical insecticides.
  - Biorational pesticides —, are a group of pesticides that are considered to be relatively non-toxic to humans and environmentally safe.
  - Breeding place —, a place where mosquito larvae develop.





Glossary

- C
  - Calibration, the testing and adjusting of insecticide application equipment to ensure a proper application rate.
  - California encephalitis, a disease of humans first reported in California caused by the California encephalitis virus.
  - CE, is the abbreviation for the California encephalitis virus. CE, is a member of the California serogroup of viruses, so-named because CE was the first virus to be classified in the serogroup.
  - Chemical control, the control of pests including mosquitoes by the use of chemicals.
  - Chemist, one who works with chemicals
  - Cholinesterase, a enzyme present at the nerve junctions in animals and is necessary for proper functioning of nerve impulses.
  - Classification, the process of arranging a series of information into groups according to common characteristics. In vector control operations, insecticides target organisms, application equipment, laws, and regulations are just a few of the things that are frequently classified. For insecticide classifications the same material can often be classified into several different groups according to target species, chemical nature, manner or formulation, mode of action, and toxicity.
  - Common name, the well-known simple name of a insecticide accepted by the federal and state insecticide regulation agencies.
  - Competitive displacement, the replacement of one population of organisms by another in a given region, usually because of superior fitness for the particular environment.
  - Conditioning, a phenomenon in certain *Aedes* mosquitoes species whereby the eggs will not hatch until they have gone through several months exposed ti very cold temperatures.
  - Cooperative agreement, a formal agreement between the California Department of Public Health and mosquito control agencies with the CDPH overseeing the local control agency's activities.
  - Complete metamorphosis, the process of insect development which includes the egg, larva, pupa, and adult stages.
  - Cross immunity, the protection from infection by a pathogen resulting from vaccination or infection by a related pathogen.
  - Cross resistance, is a situation where physiological resistance to a insecticide by an insect population results in resistance to a second insecticide group of insecticides.
  - Cuticle, the outer covering (or skin) of a arthropod.

Glossary

- D
  - **Dead-end hosts**, In epidemiology, vertebrate hosts that become infected with a pathogen, but do not serve as a source of infection for any additional hosts. This is usually because the dead-end host does not circulate pathogens in the blood in sufficient concentrations to infect new vectors.
  - **DEET**, The common name for the insect repellent *N*,*N*-Diethyl-*meta*-toluamide
  - **Dermal**, Pertaining to the skin
  - **Developmental transmission**, A type of transmission of a pathogen by a mosquito or other vector arthropod in which the pathogen undergoes developmental changes, but does not multiply. Example: the transmission of filarial worms by mosquitoes.
  - **Diapause**, in insects, including mosquitoes, an altered physiological state in which certain activities such as bloodfeeding, ovarian development, or flying are suspended. Diapause is often triggered by shortened day-lengths or low temperatures, and terminated by lengthened day-lengths or warm temperatures.
  - **Disease**, any departure from normal health in an organism. A vitamin deficiency is a disease. Infectious diseases are caused by infections with pathogenic microorganisms.
  - **Diurnal**, refers to daytime.
  - **Dorsal**, refers to the uppermost surface of an organism.

Glossary

- E
  - **Ecology**, the study of the relationship between a plant or animal and its surroundings.
  - **Ecosystem**, a type of biological organization made up of all the organisms in a given area.
  - **Emulsion**, a mixture of two unblendable substances. One substance (the dispersed phase) is dispersed in the other (the continuous phase). Examples of emulsions include butter and margarine, and milk and cream. Insecticide emulsions are created with an emulsifying agent.
  - **Encephalitis**, a disease characterized by inflammation of the brain.
  - **Encephalomyelitis**, a disease characterized by inflammation of the brain and the brain stem.
  - **Endemic**, used to describe a human disease or an organism that occurs naturally in a given area.
  - **Enzootic**, used to describe a non-human animal disease that occurs naturally in a given area
  - **Epidemic**, used to describe a human disease outbreak resulting in an unusually large number of cases.
  - **Epizootic**, used to describe a non-human animal disease outbreak resulting in an unusually large number of cases
  - **Exotic**, refers to anything that is from some other place.

Glossary

- Facultative , refers to phenomena such as diapause or autogeny where the phenomenon is variable depending upon various other factors (also see obligatory).
- Family , an taxonomic grouping of organisms containing one or more genera.

- Fauna, all the species of animals that are present in a given area, e.g., the fauna of Chile.
- Flora , all the species of plants that are present in a given area, e.g. the flora of California.

Glossary

- G
  - **Ganglion ,** A nerve mass in insects, including mosquitoes. Part of the central nervous system.
  - **Genetic control ,** A modern approach to mosquito control involving altering the genetic makeup of mosquitoes to make them infertile, reduce their ability to transmit human pathogens, or otherwise reduce their potential as pests and vectors. Usually, such genetically-altered mosquitoes are released into the environment in an attempt to “drive” the altered genes into wild populations of mosquitoes.
  - **Genus ,** A taxonomic grouping of organisms containing one or more species (Plural: genera).

- **H**
  - **Hazard ,** In toxicology, the risk of poisoning when a material is used. Hazard depends not only on the toxicity of a material, but also on the risk of toxic exposure when used.
  - **Herbicide ,** A type of pesticide designed to kill weeds.
  - **Hibernation ,** An altered state of some kind by which insects survive the winter.
  - **Hypersensitivity ,** A condition in animals in which repeated exposure to foreign antigens (usually proteins) leads to a heightened and sometimes violent reactions to subsequent exposures to the same antigens.




Glossary

- |

  - **IGR** , Abbreviation for insect growth regulator.
  - **Imported malaria** , A case of human malaria acquired by being bitten by an infected mosquito in an area not in the same general location where symptoms occur and treatment is sought.
  - **Impoundment** , An artificial body of water created by damming or diking.
  - **Indigenous** , Refers to an organism native to an area. The opposite of exotic.
  - **In apparent to apparent disease ratio,** In epidemiology, the ratio of infections that do not produce clinical symptoms to those that do.
  - **Infectious diseases** , Diseases of animals or plants caused by infectious of pathogenic microorganisms.
  - **Inorganic ,** Materials not containing carbon atoms.
  - **Insect growth regulator** , A type of biorational insecticide that kills insects by interfering with natural reproductive processes. These are usually synthetic versions of natural insect hormones, such as the juvenile hormone.
  - **Insecticide resistance** , The ability of an insect to withstand the lethal effects of an insecticide, usually by a physiological detoxification mechanism controlled by genetic mutations.
  - **Insecticide resistance management** , A combination of strategies used in insect control that tend to delay or prevent the development of resistance to certain insecticides.
  - **Integrated Pest Management (IPM) ,** A system of pest control in which various strategies are used in combination.
  - **Integrated Vector Management (IVM)** . A system for control of vectors in which various strategies are used in combination. Many people understand IPM to encompass vector control and do not use the more specific expression of IVM.

Glossary

- J
  - **Juvenile hormone** , A naturally occurring biochemical occurring in insects that controls certain processes in metamorphosis. Synthetic versions of this biochemical are used as biorational insecticides.

- K
  - **Kingdom** ,In science, one of three major categories into which natural objects are classified: Animal, Plant, and Mineral. In more recent years, additional kingdoms have been created in biology to accommodate things like viruses and fungi.

Glossary

- L
  - Label , Printed material attached to or printed on a pesticide container. The content and general format of labels is regulated by the US Environmental Protection Agency.
  - Labeling , All the technical information provided by the manufacturer of a pesticide, including the label.
  - Larvae , Immature forms of invertebrate organisms. In insects, the forms that appear after hatching from eggs and before becoming a pupae.
  - Larvicide , A insecticide used to kill larvae, usually of insects.
  - LC_{50}, A toxicological term used in pesticide testing that means the concentration required to kill 50% of a group of test subjects. The lower the number, the more toxic the pesticide.
  - LD_{50}, A toxicological term used in pesticide testing that means the dose required to kill 50% of a group of test subjects. The lower the number, the more toxic the pesticide.
  - Limiting factor , A factor, either biological or non-biological, that limits the size of a population of organisms. The most common biological factors are parasites and predators, the most common non-biological factors are weather and climate.
  - Locally transmitted malaria , A case of human malaria acquired by being bitten by an infected mosquito in the same general location where symptoms occur and treatment is sought.

Glossary

- M
  - Malaria , A disease of humans and other animals caused by protozoan (single-celled animals) parasites transmitted by insects. Human malarial parasites are transmitted by anopheline mosquitoes. Malaria is probably the most important disease in the world. It has been called, with considerable justification, the world's number one killer.
  - Malpighian tubules , Organs in the abdomen of larval and adult mosquitoes associated with excretion.
  - Metamorphosis , Changes that an insect goes through during its life cycle. Insects with complete metamorphosis have eggs, larvae, pupae, and adults.
  - Multivoltine , Many generations per year. *Culex pipiens* is a mosquito that is multivoltine.

Glossary

- N
  - *N*,*N*-Diethyl-*meta*-toluamide , The chemical name for the insect repellent commonly known as DEET.
  - Neurohormones, Hormones in insects that are secreted by special glands that are associated with the insect nervous system. Ecdysone is a neurohormones.
  - Nocturnal , Active during night time. The opposite of diurnal.
  - Non-target organism , Any organism in an environment that is not the intended target of an insecticide application.

Glossary

- O
  - Obligatory , Refers to phenomena such as diapause or autogeny where the phenomenon is established regardless of any other factors (also see **facultative**)
  - Oral , Pertaining to the mouth, as in oral toxicity, the toxicity of a chemical when taken by mouth.
  - Order , A taxonomic group of organisms containing one or more families.
  - Organic , Chemical substances containing carbon.
  - Organochlorines , A class of insecticides contains chlorine groups; includes DDT, chlordane, lindane, and dieldrin. Also called chlorinated hydrocarbons.
  - Organophosphates , A class of insecticides that contains phosphate groups; includes malathion, and parathion
  - Osmosis , The movement of water across semi-permeable cell membranes from areas of lower concentrations of dissolved ions to areas of higher concentrations. To visualize this, remember that water always seeks to dilute out solutions of ions. A mosquito in pure fresh water will tend towards water uptake; a mosquito in saline water will tend towards water loss.
  - Oviposition , The laying of eggs by an insect, including mosquitoes.

Glossary

- P
  - Palpus , In mosquitoes, one of a pair of segmented sensory appendages that arise at the base of the proboscis.
  - Parasite, An organism that lives on, and at the expense of another organism (called the host). The host may be harmed by the parasite, and if the host is a desirable plant or animal the parasite is also a pest. If the host is a pest, the parasite is a biological control agent.
  - Parasitemia, The presence of circulating parasites in the blood of a host.
  - Pathogen, A disease-producing microorganism.
  - Permeability, The characteristic of membranes and other structures that permits the passage of fluids.
  - Personal protective measures, The things individuals can do for themselves and their families to protect them from mosquito bites.
  - Petroleum oils, Insecticides refined from crude oil for use as insecticides.
  - Phylum, A taxonomic group of organisms containing one or more orders.
  - Phytotelmata, Bodies of water held by plants. Mosquito larvae often develop in such bodies, especially in the tropics.





Glossary

- P cont.
  - Physical control, The management or alteration of physical features of the environment to control mosquitoes. An example is the management of salt marshes in ways that minimize mosquito breeding.
  - Plasmodium, The generic name for the parasite causing human malaria.
  - Population, A large group of organisms of the same species living in a geographic area.
  - Population density, The number of organisms in a population expressed as a number per unit of area. Usually estimated by sampling.
  - Posterior, Situated behind. The opposite of anterior.
  - Predator, An organism that devours another organism for food. Predators are almost always larger then their prey; parasites are usually smaller.
  - Prism (tidal), The total volume of water flowing in and out of a tidal marsh by tidal action.
  - Proboscis, In mosquitoes, a bundle of individual structures called stylets that are bound together to form a snout. The proboscis is the structure involved in bloodfeeding.

Glossary

- P cont.
  - Propagative transmission, A type of pathogen transmission by mosquitoes and other arthropod vectors in which the pathogen multiplies within the vector but does not undergo any changes in developmental form. Example: the transmission of arboviruses by mosquitoes.
  - Propagative-developmental transmission, A type of pathogen transmission by mosquitoes and other arthropod vectors in which the pathogen multiplies within the vector and undergoes changes in developmental forms. Example: the transmission of malarial parasites by mosquitoes.
  - Propagative-developmental transmission, A by mosquitoes and other arthropod vectors in which the pathogen multiplies within the vector and undergoes changes in developmental forms. Example: the transmission of malarial parasites by mosquitoes.
  - Pyrethrin, The insecticidal-active chemical component of pyrethrum insecticides. Both the active ingredient and the insecticide are sometimes called pyrethrins. The correct usage would be to refer to the former as pyrethrin, the latter as pyrethrum.
  - Pyrethroids , Synthetic compounds produced for their chemical resemblance and insecticidal similarity to pyrethrin.

Glossary

- Q
  - Quinine, An anti-malarial drug prepared from the bark of the *Chinchona* tree. One of the oldest treatments for malaria known, it is still effective, especially against malarial strains resistant to other drugs.

- R
  - Reproductive potential, The maximum reproduction possible in a population in the absence of limiting factors. Reproductive potential is never reached in mosquito populations.
  - Riparian, Refers to rivers, as in riparian habitat.

Glossary

- S
  - Saint Louis encephalitis, The human disease caused by infection with St. Louis encephalitis virus (SLE).
  - Salivarian transmission, A type of transmission of disease pathogens by insects in which pathogens are introduced into vertebrate hosts by blood-feeding insects by the injection of infected salivary fluids.
  - Salivary glands, A set of glands located in the thorax of larval and adult mosquitoes. These glands contain substances that aid in feeding. In adult mosquitoes the transmission of various pathogens result from injection of infected salivary fluids.
  - Selection pressure, In population genetics any biological or non-biological factor that tends to affect a segment of a population with a certain genetic makeup more than another segment with a different genetic makeup.
  - Selective, The characteristic of insecticides that are highly specific for certain organisms, and harmless to others.
  - Sequelae, A term used to describe a pathological situation where infections with a pathogen result in signs and symptoms occurring significantly later than the original infection.

Glossary

- S cont.
  - Sexual dimorphism, The situation in biological organisms such as mosquitoes where there are significant differences in form between males and females.
  - Sibling species, Species which satisfy the definition of separate species, but are virtually indistinguishable morphologically. *Culex pipiens* and *Culex quinquefasciatus* are sibling species.
  - Sign, Evidence of exposure to a dangerous pesticide or other disease process in a plant or animal that is observable by a person other than the plant or animal affected. In people, signs are observable by others even if the person affected is unconscious. In other animals and in plants, only signs are available as evidence of poisoning or illness.
  - SLE, The abbreviation for the St. Louis encephalitis virus.
  - Species, A group of populations of potentially interbreeding living organisms. Since passage of the endangered species act, the definition has been broadened to consider a population having some demonstrable stable difference from another population as a species in the legal sense, even if the populations are potentially interbreeding.
  - Spermathecae, Structures in the abdomens of female mosquitoes in which sperm is stored. Most culicines have 3 spermathecae, anophelines have one.
  - Stadium, The time between two successive molts in insects.

Glossary

- S cont.
  - Stage, Nearly synonymous with stadium.
  - Stagnant , In reference to water, non-flowing.
  - Surveillance, The monitoring, or close watch, over something. In mosquito control, over mosquito-borne disease cases or mosquito population sizes.
  - Symptom , A feeling of unhealthiness that can be expressed by a person. It may represent a warning of pesticide poisoning. Plants cannot display symptoms, and most animals cannot display them in a readily recognizable form. Reasonable people will disagree on the question of whether non-humans can show symptoms at all, and the word symptom is often misused for “sign”.
  - Synergist , Materials that are not necessarily a pesticide by themselves but have the effect of increasing the toxicity of insecticides with which they are mixed.

Glossary

- T
  - Target organism, The organism against which a control effort is directed. In this manual, a mosquito or a weed.
  - Tolerance, As applied to pesticides, the legal limit of the amount of pesticide that may remain in or on foods marketed in the USA. Tolerances are established by EPA, and enforced and monitored by FDA.
  - Toxicity, The inherent poisonous potency of a material. Toxicity is expressed in quantitative terms such as $LC_{50(lethal}$ concentration-50, the concentration at which a material will kill 50% of some reference organism.)
  - Trachea, In insects, one of the major tubes that conduct air throughout the body of an insect. Plural form is “tracheae”.
  - Tracheole, In insects one of the fine tubules that branch off at the end of tracheae.
  - Transovarial transmission, The transmission of microorganisms from parent to offspring via infected eggs of an arthropod vector.

Glossary

- U
  - ULV, Ultra low volume. An application of a insecticide at a rate of less than ½ gallon per acre (5 liters per hectare). Because the volumes be sprayed are so small, extremely low doses of insecticide result, even when the insecticides are sprayed undiluted.
  - Univoltine, An insect that has only a single generation per year. *Aedes tahoensis* is a univoltine species.

- V
  - Vector, A vehicle for transporting a disease-producing organism (pathogen) from one host to another. In vector ecology, the most common vectors are insects and other arthropods. Vectors can transfer pathogens from one animal to another, and from one plant to another.
  - Ventral, The underside of something. The opposite of dorsal.
  - Viremia, The presence of circulating virus in the blood of a host.
  - Virus, A microorganism that can grow and reproduce only in living cells of other organisms. Often, viruses cause diseases in their hosts and are then pathogens.

Glossary

- W
  - WEE, The abbreviation for western equine encephalomyelitis virus, the virus that causes the disease western equine encephalomyelitis.
  - West Nile fever, One of the diseases caused by WNV.
  - West Nile neuroinvasive disease, One of the diseases caused by WNV.
  - Western equine encephalomyelitis, The disease cause by WEE.
  - WNV, The usual abbreviations for West Nile virus.

Glossary

- X
  - Xenobiotic, Any substance foreign or strange to life, like synthetic insecticides such as DDT.
- Y
  - Yolk, Substance within the eggs of mosquitoes providing nutritional material for development of embryos.
- Z
  - Zoogeography, The study of the geographic distribution of animals, including mosquitoes.

Appendix 2
Conversions of Units and Formulas Used with Insecticides

Length

1 mile (mi) = 1.609 kilometer (km)

1 km = 0.621 mi

1 meter (m) = 1.904 yards

1 centimeter (cm) = 0.394 inches (in)

1 in = 25.4 mm

1 micron (mμ) = 0.001 mm

1 mμ = 1/25,000 in

Liquids

1 fluid ounce (fl oz) = 0.0296 liters (l)

1 pint (pt) = 0.473 l

1 pt = 16 fl oz

1 gallon (gal) = 3.785 l

1 gal = 128 fl oz

1 pound (lb) = 0.454 kilogram (kg)

1 liter (l) = 33.81 fl oz

1 l = 2.113 pt

1 l = 0.264 gallons (gal)

Area

1 acre (ac) = 0.405 hectares (ha)

1 ha = 2.471 ac

1 ac = 43,560 ft2

Speeds

1 mile/hour (mph) = 1.609 kilometers/hour (km/h)

1 mph = 0.447 miles/second (mps)

1 km/hr = 0.621 mph

Weight

1 ounce (oz) = 0.0283 kg

1 kg = 2.205 lbs

Conversions of Units and Formulas Used with Insecticides

APPLICATION RATES

1 oz/ac = 0.070 kg/ha

1 meter/sec = 2.24 mph

1 l/ha = 13.69 fl oz/ac

1 l/ha = 0.855 pts/ac

1 kg/ha = 0.898 lb/ac

1 kg/ha = 14.27 oz/ac

FORMULAS

Gallons per acre = (5,940 x gallons per minute/nozzle)/(mph x nozzle spacing)

Gallons per minute per nozzle = (gallons per acre x mph x nozzle spacing)/5,940

Ounces per minute per nozzle = (gallons per acre x mph x nozzle spacing x 32)/1,485

Mph = distance traveled (ft)/(88 x minutes)

Mph = distance traveled (ft)/(0.47 x seconds)

Appendix 3
Additional Information

- Written materials
  - Bohart RM, Washino RK. 1978. Mosquitoes of California. Third Edition. University of California Press, Berkeley. 153 p.
  - Bohmont BL. 2007. The standard Insecticide user's guide. Pearson, Upper Saddle River NJ. 622 p.
  - California Department of Public Health, Mosquito & Vector Control Association of California, University of California. 2008. California mosquitoborne virus surveillance & response plan. Sacramento. 51 p.
  - California Department of Public Health. 2008. Operational plan for emergency response to mosquito-borne disease outbreaks (supplement to surveillance & response plan). Sacramento. 29 p.
  - Eldridge BF, Edman JD. 2003. Medical entomology. Revised edition. Kluwer Academic Publications, Dordrecht, The Netherlands. 657 p.
  - Meyer RP, Durso SL. 1998. Identification of the mosquitoes of California. Mosquito and Vector Control Association of California, Sacramento. 80 0.
  - Marer PJ. 2000. The safe and effective use of insecticides (Insecticide application compendium 1). 2nd Ed. University of California Division of Agriculture and Natural Resources, Oakland. 342 p.
  - Ware GW, Whitacre DM. 2004. The insecticide book, 6th Edition. MeisterPro Information Resources., Willoughby, OH. 488 p.

Additional Information

- Websites
  - California Department of Insecticide Regulation. http://www.cdpr.ca.gov/
  - California Department of Public Health, Vector-Borne Disease Section http://www.cdph.ca.gov/programs/vbds/
  - California Department of Toxic Substances Control Program (DTSP). A program of Cal/EPA http://www.dtsc.ca.gov/
  - California Environmental Protection Agency (CAL/EPA) http://www.calepa.ca.gov/
  - California Vectorborne Disease Surveillance Gateway http://gateway.calsurv.org/
  - CalSurv Website http://www.calsurv.org/
  - United States Environmental Protection Agency Insecticide Website: http://www.epa.gov/insecticides
  - West Nile Virus Website http://westnile.ca.gov/