CALIFORNIA COMPENDIUM OF PLAGUE CONTROL

Vector-Borne Disease Section – Infectious Diseases Branch
Updated September 2016

Objective

The purpose of this compendium is to provide information on plague to California's public health and environmental health officials, medical professionals, veterinarians, vector control professionals, land use agencies where plague is endemic, and other parties interested in plague activity within the state. The recommendations below are reviewed and updated on a periodic basis to reflect the current status of plague and plague prevention activities in California. Updates are based on a review of the scientific literature on plague, and consultation with the U.S. Centers for Disease Control and Prevention, the World Health Organization, the Council of State and Territorial Epidemiologists, and academia. Recommendations by state and federal experts and existing standards of practice outlined in this document are intended to provide guidance to individuals and agencies involved with plague detection, prevention and control in California. Except for statutes and regulations specifically cited, the information contained in this document are recommendations provided for informational purposes only and are not intended to be regulatory in effect or practice.

Content

Figures

Appendices

PART I - PLAGUE ECOLOGY IN CALIFORNIA

A. Causative Agent

The plague bacillus, *Yersinia pestis*.

B. History of Plague in California

Plague was first recorded in California and the United States in San Francisco in 1900. Plague appeared in Los Angeles in 1908. The disease was introduced into these and other West Coast seaports via infected domestic rats and humans arriving aboard ships from Asia. Outbreaks in rats and humans followed the introduction of plague in both San Francisco and Los Angeles. These outbreaks involved local domestic rats, rat fleas, and humans.

Through flea exchange, plague transferred to native, wild (“sylvatic”) rodents and was first isolated from native ground squirrels and woodrats in California in 1908. A pneumonic plague outbreak in humans occurred in 1919 in Oakland and was traced to an index patient who hunted and skinned ground squirrels. Thirteen of the 14 cases were fatal. A second outbreak of 32 cases, 31 of which were fatal, occurred in Los Angeles in 1924. The Los Angeles outbreak was associated with an epizootic among domestic rats and ground squirrels in east Los Angeles. The 1924 outbreak is the last known instance of human-to-human plague transmission in the United States. A total of 426 human plague cases occurred in California from 1900 to 1925. Fifty-five percent (234) of these cases were fatal.

From 1927 through 2015, 63 human plague cases with exposure in California were reported, all directly or indirectly associated with sylvatic rodents. Human cases have occurred in a variety of habitats and disease foci, ranging from close to sea level on the coast, to approximately 9000 feet elevation in the Sierra Nevada Mountains. Plague bacilli have been isolated from animal sources or humans in 49 of the state's 58 counties since 1900.

Since the early outbreaks, human plague cases in California have been associated with sylvatic rodent plague activity, most commonly among California ground squirrels (*Otospermophilus beecheyi*). Plague epizootics have also occurred in golden-mantled ground squirrels (*Callospermophilus lateralis*) and at least four chipmunk species (*Tamias amoenus*, *T. senex*, *T. speciosus*, *T. quadrimaculatus*), marmots (*Marmota flaviventris*) and woodrats (*Neotoma* spp.) in various regions and habitats within the state (Figure 1).

C. Plague in Humans

1. Transmission and Incubation

Plague is a zoonotic flea-borne rodent disease that is transmitted from infected to susceptible hosts through direct contact with infected animals, tissues, and infected

fleas. The most frequent means of plague transmission to humans in California is through infected flea bites (especially *Oropsylla montana*, a ground squirrel flea) from sylvatic rodents. Other potential means of transmission are via contact with infected animal tissues (from rodents, rabbits, and carnivores), airborne droplets from infected humans or animals (especially cats) with plague pneumonia or pharyngitis. Humans are incidental hosts for *Y. pestis* and play no role in the natural maintenance of plague in California; however, humans with plague pneumonia can be a direct source of human to human transmission and cause secondary cases.
The typical incubation time following exposure through direct contact or the bite of an infected flea is two to six days. For primary respiratory exposure, the incubation is usually shorter (two to four days).

2. Clinical Symptoms
There are three, well-described manifestations of plague infection in humans and several possible complications:

> **Bubonic plague** is the most common form and is characterized by an acute onset of fever and painful local or regional lymphadenopathy ("bubo").
>
> **Septicemic plague** is characterized by bacteria in the blood with no apparent bubo.
>
> **Pneumonic plague** can develop secondary to septicemic plague or can be primary, following respiratory exposure to plague bacilli.

Atypical plague presentations include pharyngitis, meningitis, endophthalmitis, and cutaneous manifestations. If antibiotic treatment is delayed or inadequate, patients with bubonic plague may develop septicemia or secondary plague pneumonia.

3. Diagnosis, Treatment, and Prevention
Plague is most often diagnosed through microscopic examination and culture of tissues (particularly lymph node aspirate, blood, sputum, or spinal fluid) and serology. Observation of bipolar stained (Gram, Wayson) coccobacilli is suggestive but not definitive for a diagnosis of plague. Confirmation of *Y. pestis* is made by direct florescent antibody test (FA) using the F-1 antigen, or by culture, polymerase chain reaction (PCR), or bacteriophage lysis. A case is considered confirmed if *Y. pestis* is isolated from a clinical specimen or a four-fold rise in serum antibody titer is observed.

Early treatment of human plague is critical to the survival of the patient. The fatality rate for untreated bubonic plague cases is approximately 50%. The fatality rate approaches 100% for untreated septicemic and pneumonic cases. Streptomycin is the antibiotic of choice for treatment of plague, particularly the pneumonic form. Other aminoglycosides (gentamicin), tetracyclines, and chloramphenicol are acceptable alternatives in the treatment of uncomplicated bubonic or septicemic plague. While multi-drug resistant strains of *Y. pestis* have been infrequently reported from Africa, there is no evidence of

reduced antibiotic susceptibility of *Y. pestis* in North America.

The California Code of Regulations (CCR) (17CCR§2596) requires strict isolation of human cases of plague. Respiratory precautions should be implemented immediately in the case of suspected or confirmed plague pneumonia. Persons with close respiratory contact to a known case should be advised to monitor themselves for onset of symptoms, particularly fever. Persons who had intimate contact with a suspect plague patient, or known exposure to potentially plague infectious animals, their fleas, and/or tissues, should be monitored and considered for chemoprophylaxis.

The Centers for Disease Control and Prevention and the World Health Organization conduct worldwide surveillance for human cases of plague. Plague, along with cholera, smallpox, and yellow fever, is an internationally quarantinable disease. Due to the potential for aerosol transmission through respiratory secretions, plague is considered a Category A (highest priority) potential biological weapon by the Working Group on Civilian Biodefense. Plague is a reportable disease in California. When laboratory or other evidence suggestive of plague in a human or an animal is found, it must be reported immediately by telephone to the local health officer (17CCR§2500 and 17CCR§2505).

No commercial plague vaccine is currently available.

D. Plague in Animals

1. Sylvatic (Rural) Plague

In California, plague is maintained in a cycle of infection among moderately resistant and susceptible rodents and their fleas within specific geographic foci. Within each focus a cyclical disease pattern exists, alternating between periods of increased activity (epizootic plague), often evidenced by die-offs of susceptible rodents, and quiescent periods wherein low levels of disease circulate among more resistant rodents (enzootic plague).

Evidence, both historical and recent, from surveillance and testing of fleas, rodents, and carnivores throughout California has identified plague in over 40 foci representing a variety of habitats. Most of these foci have not been adequately studied or described.

Susceptible or amplifying rodent species in California include ground squirrels (*Otospermophilus beecheyi* and *Callospermophilus lateralis*), certain chipmunks (*Tamias* spp.), marmot (*Marmota flaviventris*), Douglas Squirrel or pine squirrel (*Tamiasciurus douglasii*), and some species of woodrats (*Neotoma* spp.). Plague epizootics among susceptible species are characterized by a decrease in the number of rodents, by sometimes extensive mortality, and a concomitant increase in the number of infective fleas. These concurrent events serve to magnify or amplify the epizootic event. Individual rodents that are more resistant to plague may survive infection and serve as a source of continuing infection for additional animals. Surviving animals serve to perpetuate the disease over several generations and/or seasons

within a regional plague focus.

Moderately resistant rodent species are the fundamental means by which *Y. pestis* is maintained in the environment. Deer mice (*Peromyscus* sp.), meadow voles (*Microtus* spp.), certain chipmunks (*Tamias* spp.), and some varieties of woodrats (*Neotoma* spp.) are, in general, resistant to plague, though they may become sufficiently bacteremic to infect fleas, which are then capable of transferring the infection to larger, more susceptible rodent species. Among these moderately resistant populations, individual animals may succumb to the disease allowing their potentially infective fleas to seek new hosts. These rodents and their fleas interact within a complex of poorly understood biological, ecological and abiotic factors that perpetuate transmission of *Y. pestis* in an ongoing enzootic cycle.

Humans have a greater risk of exposure to *Y. pestis* from rodent fleas during epizootic plague activity. It is rare to observe fleas displaced from their host during an enzootic period. Fleas from moderately resistant species tend to be rodent-specific, are fewer in number, and rarely bite humans. Epizootic plague, on the other hand, may kill a large proportion of the susceptible rodent population. Fleas from susceptible rodents are not as host-selective as fleas from resistant species and will more readily bite humans. The mortality occurring during an epizootic results in an increase in the number of infected fleas that are displaced from their rodent hosts.

2. Plague in Domestic Animals

Domestic animals, especially cats, are susceptible to infection with plague, but are not part of the natural sylvatic transmission cycle. However, dogs and cats may play a limited role in the dissemination of fleas or rodent carcasses, thereby increasing the risk of exposure for humans.

Naturally occurring plague in dogs is rarely documented and most infections are probably subclinical. However, like wild canids, infected domestic dogs develop antibody titers in response to infection and can be valuable sentinel animals for surveillance. A high proportion of pets in a given area with elevated serologic titers may signal recent plague activity among rodents. Such a finding in dogs is valuable during human case investigations when rodent populations have suffered extensive mortality and cannot be adequately tested. Historically, dogs were used to monitor plague activity on Indian reservations and military bases in California.

In contrast to dogs, cats are highly susceptible to *Y. pestis* infection. Cats most often acquire plague via oral contact with infected rodents and their natural hunting behavior of small rodents is implicated as the primary means for their exposure. Plague in cats is characterized by a short incubation period of approximately two days, followed by a sudden onset of fever, lethargy, lymphadenopathy (commonly submandibular) with abscess formation (buboes), and less frequently, pneumonia. Cats with pneumonic plague show respiratory distress including sneezing, coughing, wheezing, nasal discharge (sometimes bloody), oral lesions, and/or lower respiratory involvement.

Untreated plague in cats is often fatal.

Feline plague is diagnosed by culture (bubo aspirate, blood, sputum, or carcass), FA testing, or serology. Diagnostic testing of suspected feline plague cases is available through the California Laboratory Response Network of public health laboratories. Because results of diagnostic testing may not be available immediately, treatment should not be delayed but started promptly based on clinical impression and supportive information (e.g., bipolar, ovoid, Gram-negative organisms on microscopy from bubo aspirate or sputum).

Cats with plague present a serious public health concern as exudates from buboes or respiratory secretions and sputum can serve as means of transmitting *Y. pestis* to humans. In California, exposure to infected cats has been linked to at least four cases of human plague, three of which proved fatal. Cats with suspected plague should be treated with antibiotics by a veterinarian and placed in isolation in a veterinary hospital. Preferred treatment consists of parenteral or oral tetracycline (or tetracycline derivative). The following precautions must be taken while handling a cat suspected of having plague:

a. Hospitalize the cat and place it in isolation until signs are completely resolved. Limit contact of veterinary staff with the cat.

b. Protect veterinary clinic personnel from secretions and other body fluids by using disposable surgical masks, gowns, and gloves while handling the animal. Thoroughly disinfect and dispose of all contaminated materials as medical waste.

c. Treat the cat for fleas at admission with an effective insecticide. Alert hospital staff to the potential hazard posed by fleas from the animal. Instruct the owner on how to treat the cat's environment and other household pets. Recommend professional pest control to the owner.

d. Contact the local public health agency immediately. In consultation with the local health officer, owners of cats with suspected plague, the treating veterinarian and staff, and others who had significant contact with the cat may be advised to receive prophylactic treatment. All persons who had contact with the cat should be instructed to monitor their health and to contact their physician immediately if symptoms, such as fever or lymphadenopathy, develop.

To help prevent plague in cats, pet owners should be advised to keep them confined and away from rodents. The American Veterinary Medical Association, American Association of Feline Practitioners, American Animal Hospital Association, and others strongly encourage owners to keep all cats indoors as much as possible. If allowed outdoors, cats should be kept within a confined area, on a leash, or closely supervised

to prevent hunting. Veterinarians should provide information on safe and effective flea control to their clients. Veterinarians should instruct their staff on the safe use of insecticides for flea control in the veterinary clinic. Suspect cases of plague in dogs or cats should be reported to the local public health agency immediately.

PART II - LABORATORY TESTING

A. Human Plague Testing

The California Laboratory Response Network provides diagnostic testing for specimens from suspected human plague cases. Appropriate specimens include blood (best if collected prior to antibiotic administration), lymph node or bubo aspirate, sputum, throat swab, and cerebrospinal fluid. Diagnostic testing includes Gram staining, Wayson staining, FA testing, culture, bacteriophage testing, and PCR.

Submission of human plague diagnostic specimens should be coordinated through the public health department who has jurisdiction for the area in which the patient is examined or hospitalized.

B. Animal Plague Testing

The California Department of Public Health (CDPH), Vector-Borne Disease Section (VBDS) laboratory, accepts sera or blood strips (Nobutos) for surveillance purposes and prepares them for plague antibody testing. Carcasses, tissues, aspirates and throat-swabs from selected animal species are tested for the presence of plague bacteria by the state's Microbial Diseases Laboratory (MDL).

Guidelines for sample collection and submission are distributed annually to local agencies that collaborate in plague surveillance. Specimens to be accepted include carcasses of wild rodents and lagomorphs, fleas, and Nobutos from wild carnivores and rodents.

In order to facilitate efficient use of limited laboratory resources, the following submission criteria for animal carcasses should be adhered to:

a. Testing is limited to those mammals most likely to be infected. See Appendix A for listings of rodents, carnivores and other mammals that are suitable for testing. Contact VBDS (530-225-2130) for questions on testing criteria and carcass submission protocols.

b. The animal should be from an area where plague is enzootic (Fig 1).

c. The animal should be an adult. Both young and adult animals may die from plague, but experience has shown that an adult animal is much more likely to test positive for plague than a young animal.

d. The animal should be in reasonably good condition for testing. Animals compromised by open wounds, desiccation, autolysis, or fly larvae cannot be adequately tested due to contamination from other bacteria.

e. Other causes of death such as physical trauma (including road kill) or rodent control (poisoning) should be ruled out prior to submission of specimens.

Animal carcasses and tissue specimens should be sent to the VBDS laboratory (address below). The plague testing submission form (see Appendix C) requests pertinent collection information and must be completed and included with the shipment. Specimens should be sealed in double clear plastic bags and shipped on frozen "blue ice" in an insulated container via an overnight commercial carrier. Label the outside of the package with the words "Biological Substance, Category B" and apply a corresponding "UN3373" label (see Appendix C). The VBDS laboratory must be contacted by telephone prior to specimen shipment.

Address shipment to:
California Department of Public
Health Specimen Receiving
Vector-Borne Disease Laboratory
850 Marina Bay Parkway
Richmond, CA 94804
Telephone: 510-412-6254

Upon receipt at CDPH, specimens are evaluated for suitability for plague testing based on carcass condition, species susceptibility to plague, and site of collection. Suitable carcasses are processed immediately, as they can provide direct evidence of a plague epizootic in progress.
Aspirates of lymph nodes and throat-swabs from domestic pets are also tested at MDL. MDL conducts FA tests and reports results to VBDS within 24 hours of receipt of suitable specimens.

Nobuto filter paper strips from rodents, lagomorphs, and domestic and wild carnivores are tested for plague-specific antibodies by VBDS with results typically available within a week.

Fleas collected from live-trapped rodents and from burrows in the field are accepted for plague testing by VBDS and tested at MDL. Plague bacteria are detected in fleas by PCR.

For information on the submission of diagnostic specimens from wildlife or domestic animals, contact VBDS at 530-225-2130.

PART III - SURVEILLANCE AND CONTROL

A. Plague Surveillance

Health officials have performed routine plague surveillance and control in California since the 1930s. Public health concerns continue to be: (1) the potential secondary transmission of plague through respiratory secretions from an initial human or feline case of pneumonic plague, (2) the export of an incubating human case from California's plague-endemic recreational areas to a location where the disease may not be recognized, thus potentiating person-to-person transmission, (3) the continuing potential for exposure among persons living in or traveling to plague endemic areas in California, (4) the potential transfer of the infection from a sylvatic source to commensal rat populations in heavily urbanized regions, and (5) the intentional and malicious use of plague bacilli as a biological weapon. Consequently, the surveillance, prevention, and control of plague remain an important public health endeavor in California.

The California Plague Surveillance and Control Program is a cooperative inter-agency program involving state, federal, and local agencies under the direction of CDPH. The program is instrumental in the prevention of human cases by incorporating education, epidemiological investigation, disease surveillance of host and vector populations, serological testing of domestic and wild carnivores, vector suppression, and disease outbreak management.

The goal of plague surveillance and control is to protect the public through early detection and suppression of plague transmission in the sylvatic cycle. This goal is consistent with the letter and intent of international, federal, and state health regulations.

B. Plague as a Biological Weapon

A modern risk from plague involves the threat of an intentional release of the plague bacteria into an urban area. A bioterrorism release of *Y. pestis* into an urban area could infect humans and commensal rodents alike, a phenomenon not seen naturally in California since the 1920s. An airborne release of plague bacteria may result in initial human pneumonic plague cases, and also may precipitate plague epizootics among rats and a secondary wave of human cases acquired from plague-infected commensal rodent fleas. Thus, health authorities must develop response plans that include not only detection and treatment of immediately affected human victims but also outline vector and rodent control measures to be taken following the release of plague bacteria during a bioterrorism event. Medical and public health response and management of plague in the event of its use as a biological weapon are summarized in a Consensus Statement of the Working Group on Civilian Biodefense (JAMA 2000; 283:2281-90).

C. Sylvatic Plague Epizootic Response

Plague in wild rodents in California is characterized by periodic, often explosive, epizootic die-offs among susceptible rodents within geographical disease foci. Plague

exists as a permanent, latent infection among more resistant species within a given focus. Rodent fleas serve as transmitters or vectors of infection among these rodent populations. The disease becomes epizootic when the bacteria enters rodent populations that are susceptible to plague amplification through increased or unnatural population densities, vector flea abundance, and other factors.

As indicated above, evidence suggestive of human or animal plague is immediately reportable to the local health authority (17CCR§2500 and 17CCR§2505) and the risk of disease transmission promptly assessed by trained vector control biologists and technicians (California Health and Safety Code (HSC) §116110). The geographic scope and ecologic complexity of sylvatic rodent plague in California creates a diverse set of surveillance and control challenges. Plague control can best be accomplished through an integrated approach involving surveillance, education, habitat management to reduce rodent attraction, control of vector fleas and rodent population management. Due to the periodic expression of epizootic plague in animal populations, appropriate monitoring and surveillance by trained vector-borne disease specialists is indispensable in plague endemic regions, particularly in areas with a history of plague activity and human cases.

Plague activity may peak during some years in which epizootics occur over hundreds of square miles under conditions of high host and vector densities. Rodents may die in areas only sparsely inhabited or rarely visited by humans. Large-scale control activities in these areas, even if logistically and economically feasible, are not justified by the limited risk for human exposure. For this reason, control strategies are aimed primarily at prevention of contact between humans and sylvatic rodents and their fleas and through specific actions to reduce rodent and flea populations in areas of human residence and activity, particularly campgrounds or other recreational areas. The presence of plague in a dense population of susceptible rodents closely associated with human activity sometimes necessitates the use of insecticides to suppress the number of potentially infective vector fleas and lower the transmission risk to humans. In some instances, temporary closure of recreational facilities in lieu of or prior to plague control is necessary when the risk of exposure is imminent.

D. Epizootic Investigation and Risk Evaluation

Reports of animal die-offs should be investigated by local and state health authorities to determine if a plague epizootic is in progress and if the public is at risk of exposure. Unnatural causes of mortality such as poisoning or shooting should be ruled out. Indirect rodent surveillance, utilizing visual observations of rodent abundance and activity, should include identification of the rodent species involved, an estimate of the impacts of the possible die-off on their population densities, and an assessment of the potential for contact between humans, rodents, and their fleas. (Evaluating rodent population changes in potential high-risk areas is made easier by routine prior monitoring to acquire baseline knowledge of rodent species present and their relative abundance.) Fleas should be collected from burrow systems and any fresh rodent

carcasses should be retained for laboratory testing. Dead rodents should not be handled directly; rodent carcasses can be safely retrieved by grasping the animal through a clear plastic bag, inverting the bag over the animal without directly touching it and sealing the bag. Label the outside with date/time and location of collection and the collector's name and agency.

Detection of *Y. pestis* from a rodent carcass or rodent fleas indicates that transmission of plague has recently occurred in the rodent population. This information should trigger a more intensive evaluation involving direct rodent surveillance and possible control recommendations, or area closure to protect the public health. "Plague Warning" signs should be posted immediately in areas where plague activity is confirmed. The general public should also be notified.

A comprehensive plague risk evaluation of the area is warranted and should include:

a. Live-trapping all available rodent species in the area to estimate the population densities of known reservoirs and amplifying species and the collection of serum specimens for the assessment of recent plague transmission. Positive serum titers from all available rodent types can provide retrospective evidence of plague transmission in the local rodent populations. Because serum antibody titers may remain elevated in resistant rodents for weeks to months following exposure, they may or may not be due to current active plague and, therefore, have limited value in and of themselves when evaluating a possible active epizootic or an extant phase shift of plague activity (amplification). The quantitative value of rodent serum antibody titers (e.g., 1:256) is chiefly determined by the robustness of the individual rodent's immunologic response and should not alone be considered an indicator of the magnitude, virulence, or temporal proximity of *Y. pestis* activity in the area. One or a few positive serum antibody titers in the absence of other supportive evidence should not be solely interpreted as evidence of active plague.

b. Assessing the extent and phase of the epizootic. A prevalence of positive serological titers among rodents can provide a rough indication of the recent level of plague activity in the rodent population, but must be interpreted within the entire context of the assessment. Other factors such as a decline in susceptible rodents, evidence of rodent burrow abandonment, fleas inhabiting burrow entrances and the presence of carrion eating flies are consistent with a recent epizootic event. These assessments are best done by personnel experienced in the interpretation of current plague activity.

c. Evaluating the abundance (flea index: number of fleas per rodent host) and infection of known vector fleas.

d. Assessing the potential for humans to be exposed to vector fleas.

e. Reviewing the area's history of plague activity and/or human plague cases.

Confirmation of plague among susceptible rodent species and/or their fleas, in combination with other risk factors such as high densities of these rodents and their fleas, evidence of a recent rodent die-off, local history of plague activity and/or human cases, and the imminent possibility for human exposure may require intervention in the disease cycle through suppression of vector fleas and the control of rodent populations. Plague control is a collaborative effort between state and local health and agricultural authorities and, in recreational situations, federal, state, and local land use agencies, and private interests (e.g. concessionaires). Decision flowcharts used for plague surveillance and response are included as Figures 2-4. See Appendix B for a risk evaluation template that can be used to summarize the investigation and communicate findings to other local authorities.

1. Protocols and Procedures Involved in Plague Surveillance

Trapping and sampling methods for rodents that minimize disease exposure ensure the safety of personnel conducting vector-borne disease surveillance (See: Methods for trapping and sampling small mammals for virologic testing, Sept. 1995, U.S. Dept. Health & Human Services, CDC).

When working with a pathogen or other hazardous substance known to adversely affect human health, special precautionary methods involving the use of personal protective equipment (PPE) are clarified under the Code of Federal Regulations (CFR) and the California Code of Regulations (CCR). Personnel engaged in rodent disease surveillance or otherwise handling live rodents are required to follow their organization's protocols and all applicable regulations regarding the use of PPE (29CFR§1910.120, 8CCR§5192). Workers conducting surveillance should be aware of the symptoms of rodent-borne diseases and should immediately seek medical attention if a febrile illness develops after a potential exposure.

2. Control of Rodent Fleas

The bite of plague-infected fleas remains the most frequent route of plague transmission to humans in California. Therefore, insecticidal suppression of sylvatic rodent fleas is the most effective means of minimizing human contact with the plague vector. Control of fleas on dogs and cats in plague endemic regions is necessary because pets may serve as transporters of rodent fleas to humans. Numerous insecticides and insect growth regulators are commercially available for control of fleas on dogs and cats. These products can be administered by the pet owner or veterinarian.

When restricted-use insecticides (insecticides not available to the general public) are used in suppressing vector fleas on public lands a use permit is required from the local Agricultural Commissioner (3CCR§6412, 3CCR§6420) and a pesticide use report must be submitted after the pesticide application (Food and Agricultural Code (FAC) §12979).

Suppression of vector fleas on sylvatic rodents should be considered when the following occur:

a. Plague activity is confirmed among susceptible rodents and/or fleas in areas of human activity.

b. Vector fleas are present and abundant.

c. There is a significant potential for humans to be exposed to vector fleas.

Suppression measures are limited to areas of actual or potential human exposure at the time of treatment. Under this regimen, routine and repetitive treatments which might lead to development of insecticide resistance are avoided. Reduction of flea density to less than one flea per rodent host is considered sufficient to interrupt transmission to humans.

The means by which insecticides are delivered to the target species are as important as the materials used. Two target delivery systems are currently approved and employed:

(1) Application of insecticidal dusts into rodent burrow systems.

(2) Application of insecticides via rodent bait stations. This method targets fleas on animals that do not use burrows for nesting, or rodents that have burrows inaccessible to direct application.

Both methods of insecticide application may be necessary where mixed rodent populations (e.g., ground squirrels and chipmunks) are involved in the disease cycle.

Burrow dusting for flea suppression is accomplished by infusing insecticide dust directly into rodent burrow systems with hand or pressurized dusters. Burrow dusting is most effective against ground squirrel fleas where rodent burrows are easily located.

Bait stations attract rodents by using a bait block or other material suspended above a layer of insecticide dust. Animals dust themselves while feeding on the bait block and on entering and leaving the station. Alternatively, a liquid insecticide can be applied to carpet that lines the inside of a modified bait station. Bait stations should be inspected every other day and attractant and insecticide refilled as necessary. Bait stations are most effective against fleas on ground squirrels, chipmunks, pine squirrels, and woodrats. Occasionally, dominant species and individuals within a species may deter entry of shyer animals into bait stations, thus leaving the more subordinate species or individuals untreated. A sufficient number of bait stations should be deployed to accommodate the rodent population density and dynamics. Bait stations should be placed no greater than 100 ft. (30m) apart. Current pesticides available for rodent flea control require approximately seven days of use in bait stations to be effective.

New and improved methods for suppression of rodent fleas are currently under investigation. Possible methods include the use of new insecticides and insect growth regulators. The rapid reduction of infectious fleas remains the prime objective in the control of plague.

3. Pesticide Application and Safety in Flea Suppression Methods

Exposure of both pesticide applicators and the general public to insecticides is of critical concern in plague control. Following pesticide label directions, worker safety regulations, and common sense practices reduce the chances of pesticide exposure to humans and non-target wildlife. The CCR and HSC have requirements applicable to public health pesticide applications. All government agency pesticide applicators engaged in flea suppression are required by law to be properly certified for public health applications of pesticides, or work under the direct supervision of a certified applicator (HSC§106925). Prior to handling pesticides, all government agency or commercial applicators must receive pesticide application and safety training for the specific pesticide product(s) (3CCR§6724). Additionally, applicators are required to wear PPE that is required by the pesticide label (40CFR§156.212). This may include disposable protective coveralls, rubber gloves, head and foot protection, and protective eyewear (3CCR§6738).

Approved respiratory protection equipment must be used when required by the pesticide label (3CCR§6739). Tight-fitting respirators must be fit-tested prior to use (3CCR§6739). Available washing facilities are required for all control operations (3CCR§6734).

Exposure of the public to insecticides should be minimized during all plague control operations by restricting access to the treatment site. The public should be notified in advance of any application procedures. Bait stations in campgrounds present a potential source of poisoning for children and pets. Bait stations should be constructed, placed, and labeled in such a manner as to prevent pesticide non-target exposure.

A post-treatment evaluation should follow all flea suppression operations to determine the success or failure of flea reduction and any environmental impacts to non-target wildlife. Appropriate reports on pre- and post-treatment evaluations and a summary of the suppression outcome should be filed accordingly. Pesticide Use Reports indicating: county where applied, agency involved in application, formulator and product used, EPA registration number, targeted pests, concentration, and the amount of pesticide used, must be submitted to the local county agricultural commissioner (FAC§12979).

PART IV - PLAGUE PREVENTIVE MEASURES

Land use agencies responsible for areas with a history of plague activity among sylvatic rodents should not rely solely on chemical control of flea populations as a comprehensive prevention strategy. An integrated disease management program that includes host population and disease monitoring, public education, and habitat manipulation to restrict rodent abundance will be more effective. Present biological and management knowledge, if properly used, can minimize potential disease hazards to humans, as well as reduce the need for intervention and temporary closure of public use areas.

A. Sylvatic Rodent Management

Sylvatic rodents are a vital component of California's natural ecosystems and can contribute to the aesthetic quality of recreational activities for many people. However, human-influenced habitat changes and increased food supply through supplemental feeding often lead to artificially and selectively inflated rodent populations. Wildlife managers and vertebrate pest specialists advocate that ground squirrel populations may be considered excessive if 20% or more of the structures, barriers or campsites have burrows present under or around them. Additionally, their numbers are considered excessive if one or more ground squirrels are observed for every two to three campsites or two to three ground squirrels seen at any one time per acre (5-7 per hectare) in areas other than campgrounds.

Repeated evidence of plague activity and/or periodic plague epizootics and high densities of plague-susceptible rodents in close proximity to humans may lead to management strategies that incorporate suppression and/or reduction of excessive rodent numbers. Various management and control methods can be used to reduce the numbers of rodents or increase the practical distance between rodents and humans. However, it is essential to ensure that fleas are controlled prior to rodent control to avoid exacerbating the risk of human exposure to infected fleas.

1. Sanitation

Rodents normally obtain food from natural sources. However, they are opportunistic and will readily take advantage of supplemental food such as garbage, spilled pet food, or handouts from campers and recreational area visitors. Visitors should be encouraged to store all food in sealed containers that are inaccessible to rodents. Similarly, visitors should be instructed to dispose of all garbage and food waste in tightly sealed dumpsters and garbage cans. Finally, visitors should avoid feeding wild rodents.

2. Habitat Modifications

Human-influenced habitat additions (e.g., barrier logs, rock walls, concrete pads, structures and material constructs like wood piles) provide refuge for wild rodents that contribute to unnaturally high rodent populations, particularly when coupled with

supplemental food. These features are often located near areas of human activity and greatly potentiate human-rodent-flea contact.
Burrowing rodents such as ground squirrels often benefit from these additions particularly when burrowing is possible in loose soil directly under the material. Additional benefits are derived by rodents if the additions lend themselves to the construction of nest sites. Thick brush cover around these additions may further attract rodents to these sites.

Habitat modification of recreational and home environments should include the following:

a. Trim thick brush at least 15 feet (5 meters) away from homes and structures, or from campsites in recreational areas.

b. Remove fallen logs.

c. Place logs used as barriers on pedestals at least six inches off the ground.

d. Cut and remove tree stumps.

e. Bury large rocks used as barriers or for decorative purposes 1/3 to 1/2 below grade.

f. In campgrounds, campsites should be located away from large rocks or boulders where rodents normally construct burrow systems.

g. After road construction, rocks should be removed and banks well compacted. Metal barriers, rather than logs, should be used as roadway barriers.

h. Cover and compact exposed root systems from trees.

i. L-shaped concrete footing lips or stiff wire mesh (10 inches wide and buried 8 inches below ground adjacent to pads) should be used instead of shallow concrete pads or low wooden risers in building foundation construction to thwart digging rodents.

j. Seal gaps between walls and roofs, and access areas of lower walls in structures.

k. Eliminate sources of supplemental food and water (e.g., leaking faucets).

3. Rodent Proofing

To successfully exclude rodents from buildings, food storage boxes, and refuse containers requires implementation of exclusion methods preferably during construction of the facility. The screening of vents, providing tight fitting doors, and plugging gaps where pipes enter buildings are essential measures. The proper design and construction of buildings and camping facilities that emphasize rodent exclusion

significantly prevent rodent access and habitation.

4. Trapping

Although labor-intensive, trapping may be an effective auxiliary method of reducing rodent numbers. Because rodents such as ground squirrels and chipmunks are disease hosts, possibly infective, and animals relocated from their home range have a limited survival potential, they should not be relocated or released elsewhere. Animals that are live-trapped for removal should be humanely euthanized. In regions with a history of plague activity, rodent control should be preceded by flea control, as outlined above.

Live traps should be used for trapping ground squirrels, chipmunks, and woodrats. To be successful, trapping must be done overnight for nocturnal rodents like woodrats. Traps are placed approximately 50 ft. (15m) apart to adequately cover the survey area. Traps should be checked frequently so any non-target animals can be released. To minimize possible disease exposure, rubber or plastic gloves should be worn when handling traps containing captured rodents or rodent carcasses. Dead rodents should be double bagged in tightly sealed plastic bags and properly disposed or buried.

5. Toxic Baits

The use of multiple dose anticoagulant rodenticides help to minimize exposure risk for human and non-target species. To be lethal, this type of rodenticide must be consumed over a number of days because the anticoagulants toxicity is cumulative. Anticoagulant baits are readily accepted by wild rodents. The best time to use anticoagulants is in the spring after rodents have emerged from hibernation and prior to reproduction.

As with the use of restricted-use insecticides for flea suppression (see above) the application of restricted-use toxic baits for rodent control must be coordinated with the local County Agricultural Commissioner prior to use (3CCR§6412, 3CCR§6420, FAC§12979). When anticoagulant baits are used in bait stations, the stations should be designed and placed as to prevent access by people and non-target animals. Label instructions should be followed carefully during the application of anticoagulant baits. An awareness of any endangered or threatened species within a region should be considered in rodent management operations where toxic baits are used.

B. Health Education

The appropriate and timely use of news media, informational brochures, posters, and word-of- mouth information in the form of lectures, interpretive programs, and training courses are key elements of plague control. Many sylvatic rodent associated plague cases can be prevented if people are aware of the potential for exposure in plague endemic areas and are educated to avoid potentially plague-infected rodents and fleas. Residents can learn about the necessity to treat pets for fleas, remove rodent harborage, rodent-proof structures, and carry out control measures against rodents and fleas on their properties. Campers and visitors to recreation areas can be alerted with plague informational brochures and posted signs that explain the hazards of plague,

how to avoid it, and where to report evidence of rodent morbidity or mortality. In addition to public information, the medical and veterinary communities should be kept informed of endemic plague regions, recent plague activity and surveillance, and be provided with current information on case occurrence, diagnosis, precautions, treatment and therapy.

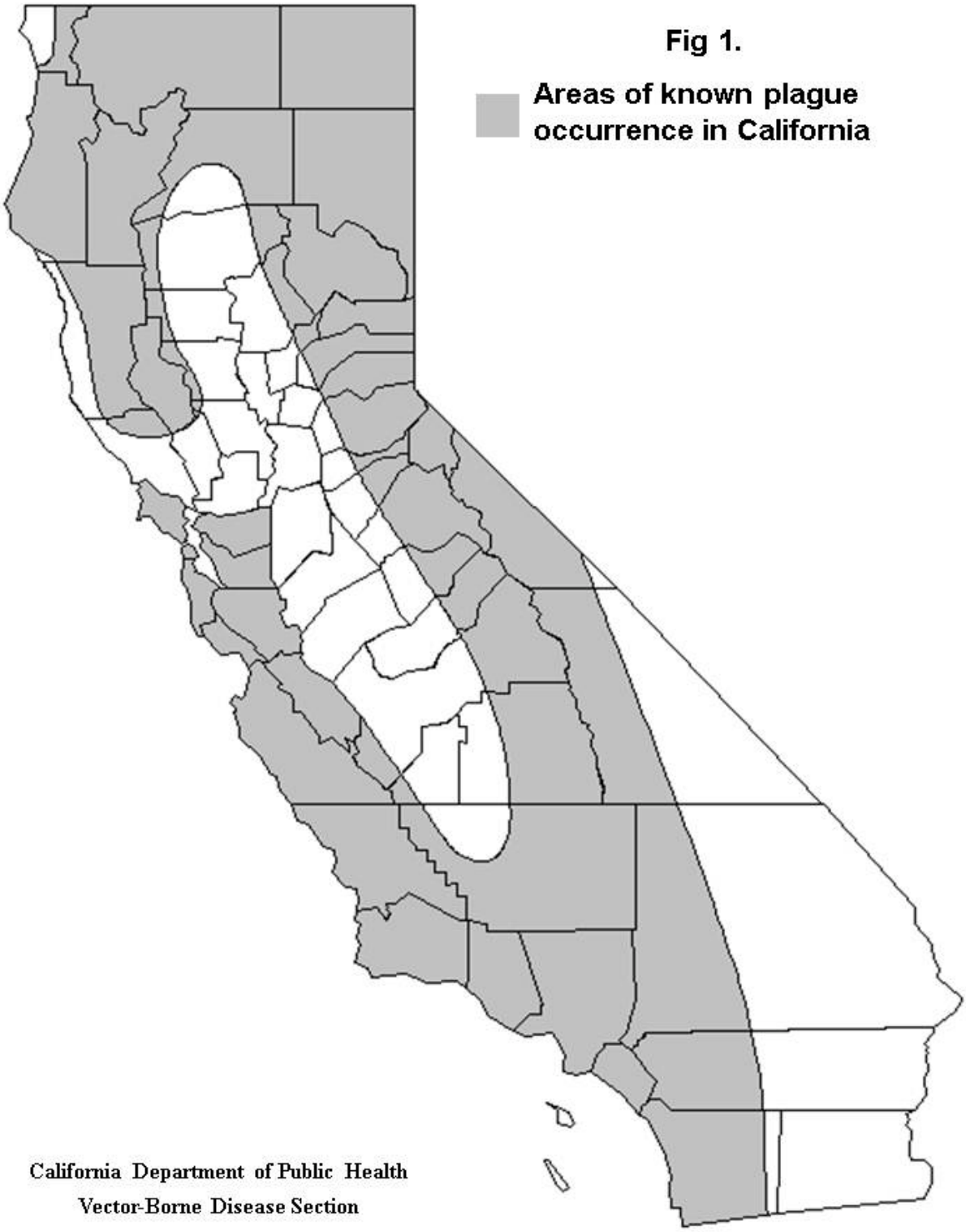
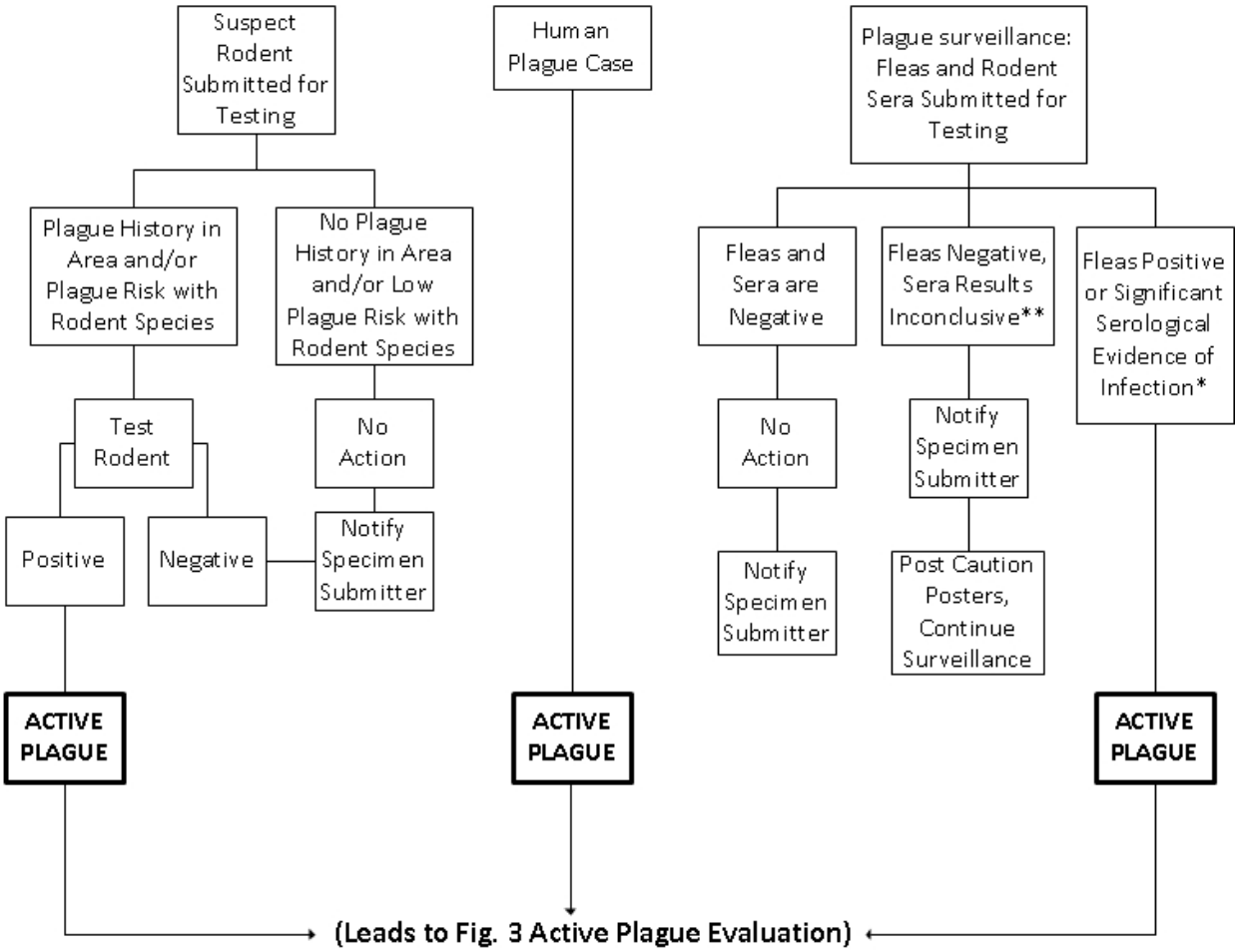


Fig 1.
Areas of known plague occurrence in California
California Department of Public Health
Vector-Borne Disease Section

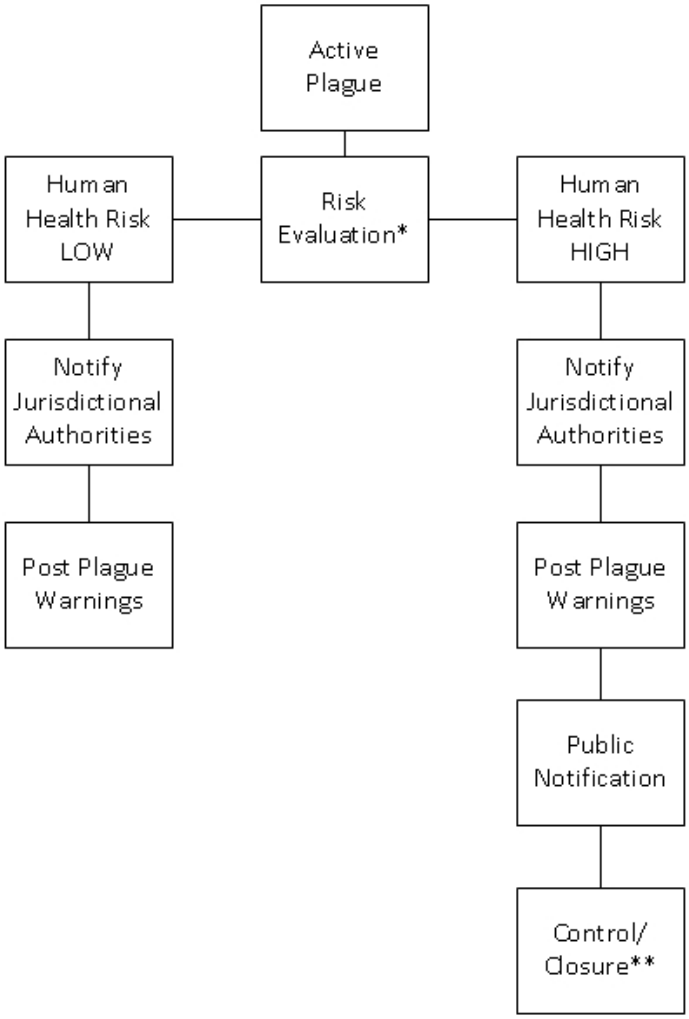
Fig. 2.
Plague Detection



*High antibody levels and a high proportion of serologically positive animals indicate more recent and increased plague activity. A large percentage (25-40%) of sera with relatively high titers (1:256 or greater) should prompt additional investigation.

**Inconclusive sera results can occur from: small sample size with negative antibody results; few positives and/or low titers (less than 1:256).

Fig. 3.
Active Plague



***RISK EVALUATION**

1. Past history of disease and evidence of current epizootic activity.

2. Presence and densities of susceptible and resistant rodent species.

3. Presence of vector fleas and bite exposure potential.

4. Human usage and exposure potential.

****CONTROL/CLOSURE RECOMMENDED IF:**

History of past disease and current epizootic documented.

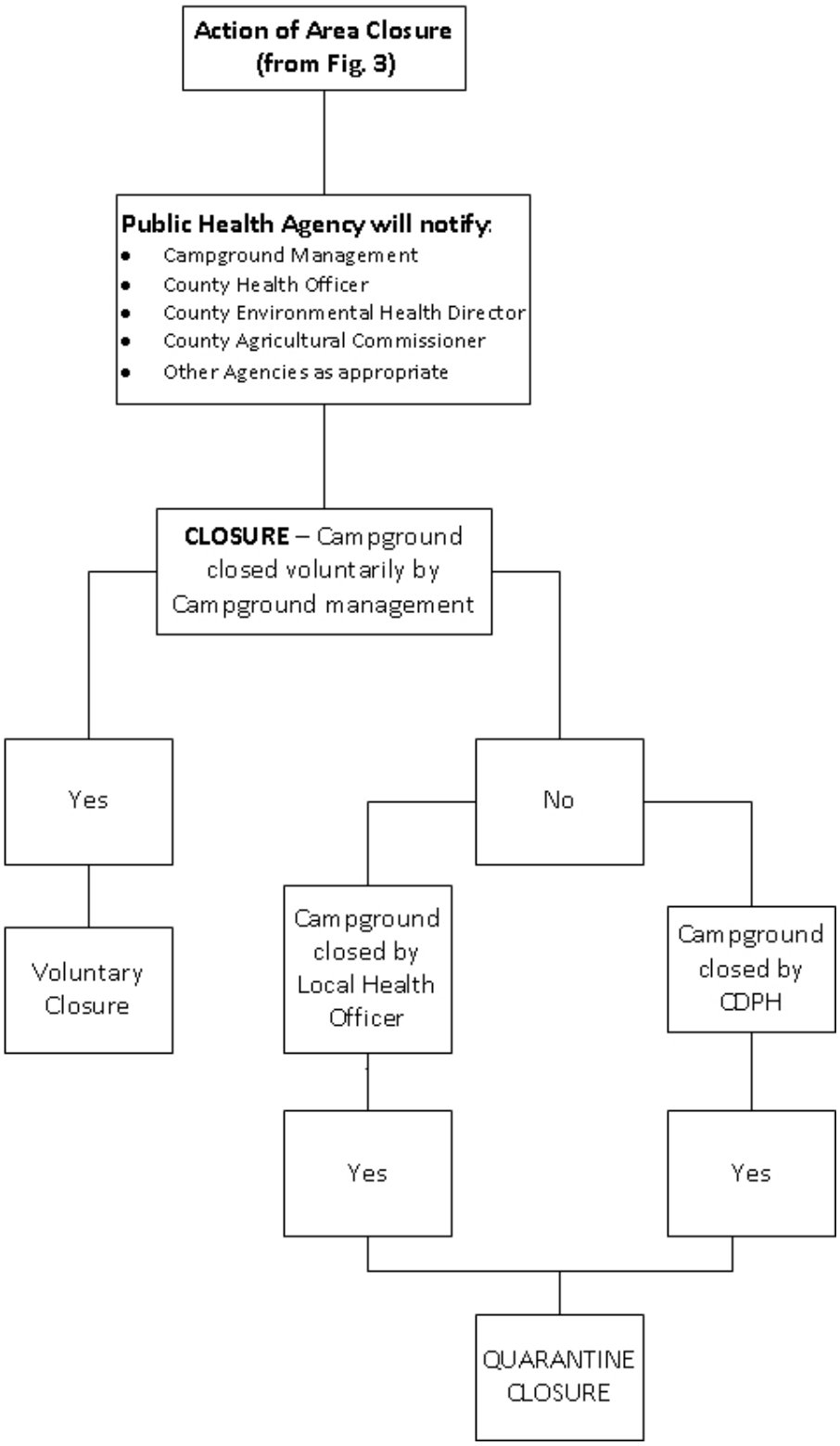
High density of disease susceptible host rodent species present.

Vector fleas present, species readily bite humans – exposure potential for human transmission is high.

High human usage and close co-mingling of humans, disease hosts, and vectors.

Potential for pesticide exposure to humans.

Fig. 4.
Procedures for Closure of Recreational Areas for Plague Prevention



Appendix A: Submission Criteria for the Detection of *Yersinia Pestis* (Plague) in Rodents and Lagomorphs (Carcasses and Serum) From California

Based on information provided by years of plague surveillance conducted in California by the California Department of Public Health, Vector-Borne Disease Section (CDPH, VBDS) the following small mammals are species suitable for plague testing.

Rodentia

California or Beechey ground squirrel	*Otospermophilus beecheyi*
Belding's or Oregon ground squirrel	*Urocitellus beldingi*
Golden-mantled ground squirrel	*Callospermophilus*
lateralis Douglas Squirrel, Pine squirrel, chickaree	*Tamiasciurus*
douglasii Chipmunks (all species)	*Tamias* spp.
Northern flying squirrel	*Glaucomys sabrinus*
Marmot	*Marmota flaviventris*
Woodrats (all species)	*Neotoma* spp.
Deer mouse	*Peromyscus maniculatus*
Brush mouse	*Peromyscus boylii*
Canyon mouse	*Peromyscus crinitus*
California mouse, parasitic mouse	*Peromyscus californicus*
Meadow mice, voles (all species)	*Microtus* spp., *Clethrionomys* spp.

Lagomorpha

Brush rabbits	*Sylvilagus* spp.
Pika	*Ochotona princeps*

Rodent carcasses submitted for bacteriological testing should be from an area of known plague occurrence. Other causes of death (e.g., trauma, shooting, poisoning) should be ruled out. The carcass should be fresh and in good condition as it is difficult to obtain a bacteriological test from a desiccated or maggot-ridden carcass due to contamination from other bacteria. Place the specimen in an appropriately-sized **clear plastic bag**, and then place this bag in a second plastic bag. The bagged specimen should be identified with locality, date found, the contact person or agency, and a phone number for notification. The specimen should be packaged with frozen blue-ice, labeled as "Biological Substance, Category B" (see Appendix C), and shipped in accordance with applicable laws and regulations.

Submission Criteria for Plague Testing of Wild Carnivore Sera in California

CDPH, VBDS plague surveillance information of large wild mammals since 1974 has determined the following animals most appropriate for the testing plague serum antibody.

Carnivora

Coyote	*Canis latrans*
Gray fox	*Urocyon cinereoargenteus*
Red fox	*Vulpes vulpes*
Black bear	*Ursus americanus*
Raccoon	*Procyon lotor*
Pine marten	*Martes americana*
Striped skunk	*Mephitis mephitis*
Spotted skunk	*Spilogale putorius*
Long-tailed weasel	*Mustela frenata*
Badger	*Taxidea taxus*
Mountain lion	*Puma concolor*
Bobcat	*Lynx rufus*

Artiodactyla

Feral pig	*Sus scrofa*

The following animals have limited value in plague surveillance and will be tested only after special arrangements have been made with CDPH, VBDS.

Rodentia

Gophers	*Thomomys* spp.
Kangaroo rats	*Dipodomys* spp.
Pocket mice	*Perognathus* spp.
Western gray squirrel	*Sciurus griseus*

Lagomorpha

Jackrabbit	*Lepus* spp.

Eulipotyphla

Moles	*Scapanus* spp.
Shrews	*Sorex* spp.

The following animals have limited value in plague surveillance and samples should not be submitted for plague testing.

Didelphimorphia

Opossum	*Didelphis virginiana*

Rodentia

Beaver	*Castor Canadensis*
Porcupine	*Erethizon dorsatum*

Appendix B: CDPH Vector-Borne Disease Section
Plague Surveillance Risk Evaluation Form

Jurisdiction (Forest Service, State Park, etc.) _____ County _____

Ranger District _____ Ecological Zone _____

Survey Location _____ Contact Person _____

Concessionaire _____ Phone number _____

Campground Host _____ Email address _____

Date _____ Time _____ Weather _____ Elevation _____

Risk Assessment Factors (RAF): Rank each from 0-5 points. 0 = no risk; 1-2 = Low Risk; 3-4 = Moderate Risk; 5 = High Risk

Note: These scores are primarily subjective; ratings should be based on past experience and local knowledge of plague ecology. This form should be used as a general guideline to evaluate a situation and communicate findings. Please consult the Compendium for additional details and contact CDPH for assistance.

1. **Plague History Assessment** (Previous plague activity, including human cases, documented in local area)

RAF_____

_____

2. **Plague Susceptible Species** (Presence and abundance of known plague susceptible rodents - infection in these species can rapidly amplify disease activity)

RAF_____

_____

3. **Moderately Resistant Species** (presence and abundance of known rodent reservoirs - these rodents typically exhibit less mortality than susceptible species but previous plague exposure often demonstrated by serological antibodies)

RAF_____

_____

4. **Human Exposure Assessment** (Abundance and proximity of rodents and burrow systems to campsites, trails, occupied buildings, or other areas with significant human use)

RAF_____

_____

5. **Release Assessment** (Potential for infected rodents and fleas to spread plague. For example, infected fleas, vector fleas abundant on susceptible rodents, signs of a rodent die-off such as carcasses, burrow abandonment, fleas on the surface or in burrow entrances, presence of carrion flies in or near burrows)

RAF_____

_____

Recommendations/additional observations

Total Score (add RAFs together, 25 possible points) _____

Risk Assessment (total score divided by 5) _____

2.0 or below = Low Risk
2.1 - 4.4 = Moderate Risk
4.5 - 5.0 = High Risk

Evaluator _____

Appendix C

PLAGUE TESTING SUBMISSION FORM
VECTOR-BORNE DISEASE LABORATORY

Collector(s):

Collecting agency:

Jurisdiction (e.g. Forest Service, State Park, Private):

Date Collected:

Location (general):

Specific location (e.g. campsite number, by dumpster):

County:

Elevation:

Lat/Long:

Comments about condition/behavior:

Address shipment to:
California Department of
Public Health Specimen
Receiving Vector-Borne
Disease Laboratory 850
Marina Bay Parkway
Richmond, CA 94804
Telephone: 510-412-6254

UN3373

BIOLOGICAL SUBSTANCE, CATEGORY B

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