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MANAGING PLAGUE IN ENDANGERED SPECIES HABITATS

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ABSTRACT: Plague is an endemic disease among field rodents in the southwestern United States. Epizootic outbreaks of this disease increase the risk of human infection where man comes into contact with infected rodents or their fleas. The risk is further increased when colonial rodents are involved, since these animals are usually found in large numbers and are often found in locations where people live, work, or enjoy recreational activities. Elimination of large numbers of susceptible rodents from a particular location following a plague epizootic usually results in a quiescent period when plague is neither a threat to those rodents moving into the former colony confines or a threat to people using the same geographic area. In areas where the human health threat following an epizootic is unacceptable, susceptible rodents and their fleas may be eliminated through trapping or poisoning the animals and dusting the burrows with insecticide to kill the fleas. In recent years, however, the health (or death) of prairie dogs (*Cynomys* spp.) or California ground squirrels (*Spermophilus beecheyi*) has become a significant ecological issue in areas where these rodents are the predominant prey base for endangered species of animals. Prairie dogs often support populations of endangered raptors while California ground squirrels may support the endangered San Joaquin kit fox (*Vulpes macrotis mutica*). In some areas of central California, where the kit foxes are supported by ground squirrels, reduction in the number of rodents to reduce the threat of plague is prohibited. Confounding the management of plague, limitations may be placed on the types of insecticides used for flea control following an epizootic. When insecticide use is permitted, preventive flea control to protect rodents from plague results in a continuous, sustainable population of highly plague susceptible rodents. When flea suppression fails, replacement animals can be trapped and relocated to areas decimated by plague. Not only are these types of plague management expensive in terms of manpower, equipment and time, but the potential of epizootic plague is constantly present.

KEY WORDS: epizootics, rodents

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INTRODUCTION

Plague was first introduced into North America in 1900 via Norway rats (*Ratus norvegicus*) aboard ships from Asia (Pollitzer 1954; Link 1955). The disease was quickly spread by infected fleas to urban rat populations in port cities along the Pacific and Gulf coasts (Prince et al. 1965). Human plague in the United States remained a largely urban disease until the 1920s (Barnes 1982) when improved sanitation programs and rat control projects virtually eliminated plague from the port cities where it was first introduced (Prince et al. 1965). During this time period, plague was being spread through sylvatic rodent populations in the west following transfer of the disease between the infected urban rodent/sylvatic rodent interface (Nelson et al. 1986). It was not until the 1960s that there was a resurgence of human plague cases in the United States (Barnes 1982). This phenomenon was brought about through the explosive migration of people from urban population centers into more rural suburban areas of the west. Suddenly, housing developments were built within or adjacent to habitats in which plague was maintained in an enzootic state by the local rodents and their fleas (Nelson 1984; Baker 1984). At the present time, evidence of plague has been found in the majority of counties located west of the 100th meridian (Barnes 1982).

BACKGROUND

Plague is maintained in enzootic habitats through infected rodents (Nelson 1982). Some rodents may carry the disease without any outward signs of infection, other rodent species may have a variable response to plague,

and some species are highly susceptible to disease (Stark et al. 1966). When plague kills a rodent, fleas, many of which may be infected, remain alive and actively seek a new vertebrate host. If this occurs among relatively solitary rodents, then the infected fleas left without a host in the environment may pose little threat to humans on a geographical basis. However, the greatest threat to humans occurs when colonial rodents, such as California ground squirrels (*Spermophilus beecheyi*) and prairie dogs (*Cynomys* spp.) are infected with plague. These animals are almost universally susceptible to plague, die very quickly, and usually leave behind large numbers of live, plague-infected fleas following an epizootic. Not only do these rodents amplify plague in the affected area, but the peridomestic nature of these colonial rodents often places them in close proximity to human activity.

EPIZOOTIC PLAGUE

Plague epizootics among colonial animals seem to occur on a cyclical basis. Widespread dieoffs of prairie dog or California ground squirrel colonies oftentimes follow a five to seven year period. This does not mean, however, that plague disappears from a particular geographic area since enzootic plague among solitary rodents can be found in almost any area which experiences epizootic plague on a recurring basis. One explanation for this cyclical phenomenon is based on geography and rodent density (Nelson 1980). For example, when prairie dog or ground squirrel colonies are somewhat contiguous within a geographic area, plague can be easily spread to nearly all of the animals regardless of where it is introduced into the population

(Stark et al. 1966). Plague-infected fleas may be carried within colonies and to adjacent colonies by the prairie dogs/ground squirrels themselves or by carnivores which are feeding on the rodents. When the plague epizootic is over, very few prairie dogs/ground squirrels are usually left alive and are usually isolated in small pockets within the former colony boundaries. Although plague may continue to be present in the following years, transfer of infected fleas across the long distances separating these small isolated prairie dog/ground squirrel colonies does not always occur. It may take years for the original dieoff area to be fully repopulated by those prairie dogs/ground squirrels which survived the epizootic and other prairie dogs/ground squirrels migrating from outside the formerly affected colonies (Crosby 1986).

PLAGUE CASE STUDY—PRAIRIE DOGS

The following example will illustrate a typical plague epizootic among black-tailed prairie dogs (*Cynomys ludovicianus*). The area in question was a 27-square mile military installation which contained approximately 4,500 acres of prairie dog colonies. In November 1988, installation personnel noticed the absence of prairie dogs in a colony comprising approximately 800 acres. Closer examination of the affected area indicated that prairie dogs had not been active for at least the past several months. Vegetation was encroaching on the burrow mounds, dried vegetation and other debris were found in many of the burrow entrances, fecal pellets were hard and weathered, and there were virtually no live prairie dogs within the area. Live prairie dogs were found in an adjacent colony just south of the affected area. Plague was suspected, but could not be immediately confirmed. Since coyotes are good sentinel animals for plague (Barnes 1974, 1982), four of the predators were captured in the die-off area and small blood samples were taken. Subsequent testing of the blood showed that all of the coyotes had positive titers to plague. While this indicated the carnivores had been feeding on plague-infected rodents, it was still not absolutely certain that their prey had been taken from the die-off area. Attempts were made to recover live fleas from the rodent burrows, but the cold winter temperatures made this approach impractical. In March 1989, fleas were extracted from prairie dog burrows in the die-off area. At the same time, prairie dogs in the colony adjacent to the southern end of the die-off area began to die; examination of the carcasses revealed plague infection. The local county and state health officials were notified that a plague epizootic was underway.

Permethrin dust, the insecticide of choice since it had been shown to provide long-term flea control, particularly in dry climates (Maupin et al. 1991), was applied at a rate of 3/4-ounce per burrow in a 1/4-mile band around the perimeter of the installation. This measure was taken to kill any live plague-infected fleas which could be carried by prairie dogs off the installation to the adjoining civilian community or which could be picked up and carried off the installation by dogs and cats wandering into affected colonies. Once the perimeter was dusted, flea control efforts were begun on interior prairie dog colonies. By June 1989, only 250 acres of prairie dogs were left alive. This plague epizootic had killed approximately 95% of the

original prairie dog population within seven to eight months. From a human health viewpoint, the flea control efforts had been a success. Based upon the remaining numbers of prairie dogs, it would take a minimum of five to seven years before the 4,500-acre prairie dog habitat would be fully repopulated. Although plague could still infect the remaining prairie dogs, their small numbers and the relatively long distances between colonies significantly minimized the health impact of epizootic plague.

In terms of plague, the reduction in the number of highly susceptible animals and their fleas was an ideal situation. However, this military installation was undergoing a change in status under which the U.S. Fish and Wildlife Service was taking over the land management from the Army. One of the more important aspects of this newly emerging wildlife area was the use of the land by raptors, particularly bald eagles. These birds had a history of wintering on the installation, and utilized prairie dogs as a significant part of their prey base. With the upcoming bald eagle migration and the loss of virtually all of the prairie dogs to plague, extraordinary measures were taken. Prairie dogs were live-trapped from areas off the installation and were released into the previous plague dieoff areas. In order to minimize the potential for bringing in plague infected animals, the prairie dogs were sprayed with a light application of pyrethrin insecticide to kill any fleas prior to their relocation. Even if some of the animals had plague at the time of trapping, without a flea base, the death of some prairie dogs in the reintroduction area would have little impact on the rest of the prairie dogs. Eventually, some of the prairie dog colonies were repopulated in sufficient numbers to provide an attractive source of food for eagles in the area. These prairie dogs would also provide greater numbers of animals to breed and disperse into the former colonies decimated by plague.

From a wildlife point of view, the resolution of plague described above was highly desirable since the natural repopulation interval had been artificially accelerated. However, from a human health perspective, the chance of epizootic plague within the community had also been artificially accelerated. In situations such as this, flea dusting of burrows with healthy prairie dogs would reduce the chance of epizootic plague and insure a continuing prey base for the eagles. This methodology, while incurring labor and chemical costs, may not outweigh the cost of capture and relocation of prairie dogs. However, as the number of prairie dogs increases, the cost of constantly maintaining flea-free colonies rises exponentially. Along with the increasing number of prairie dogs and the rising cost of flea control, the chance of epizootic plague in these highly susceptible rodents rises significantly.

The illustration used in the case study described above is not unique. The same scenario can be applied where prairie dogs make up the prey base at black-footed ferret reintroduction sites. Preventive flea control must be weighed against the introduction of plague and the cost of reintroduction of prairie dogs following a dieoff. While human health is paramount in any plague epizootic, maintenance of plague-free prairie dog colonies in ferret areas is certainly a major consideration.

PLAGUE MANAGEMENT—CALIFORNIA GROUND SQUIRRELS

Another example of departure from traditional plague management occurs in central California where the California ground squirrel forms the prey base for the endangered San Joaquin kit fox (*Vulpes macrotis mutica*). While the number of ground squirrels is not in jeopardy as in the case of prairie dogs mentioned above, management of plague from a human health perspective has been altered. Because of the peridomestic nature of the ground squirrels, they are often found in close proximity to offices, family housing, or recreation areas (Harrison 1995). Since the fleas which infest the squirrels are highly successful plague vectors (Kartman and Prince 1956) and readily bite man (Pratt and Stark 1973; Maupin et al. 1991), plague infection of these rodents poses an immediate threat to the humans in the vicinity of the burrows.

One of the traditional methods of ground squirrel control in plague endemic areas is the burrow application of aluminum phosphide fumigant (Salmon and Schmidt 1984) which not only kills the animals, but also kills the fleas. This method is preferred over control methods using poisons which kill the squirrels, but may leave live plague-infected fleas in the burrows. Because the label on the fumigant prohibits its use within one mile of a kit fox den, use of this material is virtually eliminated. The alternative method of control is live-trapping and removal of the ground squirrels from the immediate vicinity of high human use areas. While this method works, it is more costly in terms of the labor required. Flea control must be done in the burrows from which the animals have been removed (Poland and Barnes 1979), and the trapping efforts must be continuous since the void created by removing the ground squirrels is quickly filled by new animals migrating into the area.

Another confounding issue is the choice of insecticide for flea control during a plague epizootic. Some of the more effective, long-lasting insecticides are prohibited from use because of the danger they may pose to the health of kit foxes which eat squirrels which may have insecticide dust on their bodies. The insecticides which are deemed "safe" for use in the ground squirrel colonies may be effective in killing fleas for a limited period of time. This means that repeated insecticide application may be needed, adding increased costs which would not normally be incurred if the endangered kit foxes were not present in the control areas.

DISCUSSION

Plague is a natural phenomenon in the western United States. Concern for human health in plague endemic areas is as keen as it has ever been. Traditional plague control efforts have been based on management of rodents which amplify plague during epizootics and on elimination of plague-infected fleas from rodent die-off areas. Increased emphasis has been recently placed on preserving habitats of endangered birds and mammals. Some of these endangered species utilize rodents, which amplify plague, as the primary prey base. Because plague can severely deplete this food source, prevention of plague in amplifying rodent populations has been undertaken as a way of maximizing rodent numbers. When prevention of

plague has not always been possible, rodents have been trapped and relocated into the plague die-off area in an effort to restabilize the prey base. Restrictions on the choice of insecticides and rodenticides in endangered species habitats have resulted in the use of less efficacious means of control. The artificial manipulation of rodent populations, preventive flea control on rodents, and limitations on the use of the most effective insecticides for flea control, have not only increased the potential for epizootic plague, but have also increased the cost of plague management in endangered species habitats.

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