

Washington State Department of Health
Zoonotic Disease Program

Plague

Plague Surveillance in Washington State
Summary Report, 1975 - 2008

December 2009



Plague Surveillance in Washington Summary Report, 1975-2008

This report provides a historical overview of plague in the state of Washington and summarizes wildlife plague surveillance for July 1975 through June 2008.

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Plague Surveillance Partners

We wish to acknowledge and thank our surveillance partners for their contributions:

Partners

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Sean Carrell, Washington State Department of Fish and Wildlife

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Plague Surveillance in Washington

Statewide plague surveillance in wildlife reveals that about 3 percent of the carnivores surveyed fed upon plague-infected rodents and that the disease is endemic in the state.

Plague

Plague is a systemic bacterial infection of rodents caused by *Yersinia pestis*. It is typically transmitted to humans and other animals through bites by infected fleas or handling infected animals with the resulting entry of *Y. pestis* into cuts or abrasions. In humans, the disease can cause illness and death when not promptly treated.

Human plague infections average 5 to 15 cases each year in the western United States. About 1 in 7 of those infected die from the disease. Occurrences are mostly scattered and occur primarily in rural to semi-rural areas. Human plague is mostly concentrated in two regions: in northern New Mexico, northern Arizona, southern Colorado, and southern Utah and in California, southern Oregon, and far western Nevada. Occasionally, human plague occurs in other western states including Montana, Idaho, Wyoming, Texas, and Washington.

History of Plague in Washington¹

Human Plague Infections

Washington's reported history of human plague began in 1907, when three (possibly seven) people died in Seattle. Rats were subsequently trapped, tested, and found positive for plague from 1907-1917. Plague reappeared in Puget Sound when fleas from rats and other rodents tested positive for *Y. pestis* in Tacoma from 1942 to 1944, 1954, and again in 1971. The introduction of plague into Seattle and Tacoma was attributed to flea-infected rodents or persons arriving on foreign vessels, or flea-infested rodents transported in grain shipments from eastern Washington. Both cities instituted a rodent control program that included trapping, poisoning, and rat-proofing buildings and garbage disposals and was ultimately successful in suppressing plague transmission.

The oriental rat flea, *Xenopsylla cheopis*, is the primary vector of plague in most large epidemics around the world and was the likely vector in Washington's early, urban plague epidemics. This flea species had been collected in Snohomish and King Counties and was likely introduced into Washington ports by rats arriving on foreign vessels.²

Since 1907, only one human plague case has been reported in Washington. This case occurred in Yakima County in 1984, and involved an animal trapper. The trapper was most likely infected when cutting himself while skinning a bobcat.

Plague in Wildlife

Evidence suggests that incidents of epizootic plague have occurred sporadically among ground squirrel populations in eastern Washington as early as 1896.³ Figure 1 shows the distribution of ground squirrel die-offs by county reported from 1914 through 1938. During this time period, unusual numbers of dead squirrels were observed in seven counties (Adams, Benton, Columbia, Garfield, Klickitat, Lincoln, and Spokane), suggesting plague activity in areas of eastern Washington. In 1937, plague was confirmed in ground squirrels from Adams County. Since then, plague studies have been conducted intermittently in the state. From 1937 through 1941, positive

plague specimens, fleas, and tissue samples were collected from ground squirrels located in Adams, Lincoln, Spokane, and Stevens Counties and from cottontail rabbits in Lincoln and Spokane Counties. From 1947 through 1954, positive fleas were obtained from chipmunks, field mice, and voles located in Yakima, Kittitas, Douglas, Grant, and Lincoln Counties.

The sagebrush vole, *Lagurus curtatus pauperrimus*, is considered to be a major reservoir of plague in eastern Washington. The flea, *Oropsylla bacchi johnsoni*, to date collected only from Washington and Oregon, is host specific to the sagebrush vole. It plays an important role in maintaining *Y. pestis* in the vole population and serves as an efficient vector of plague.

Another flea, *Oropsylla montana*, the primary vector for plague in North America, is commonly found on the California ground squirrel, *Spermophilus beecheyi*. California ground squirrels are competent reservoirs of plague and are found in the south central Cascade Mountains of Washington.

Figure 1. Distribution of reported ground squirrel die-offs by county, 1914-1938

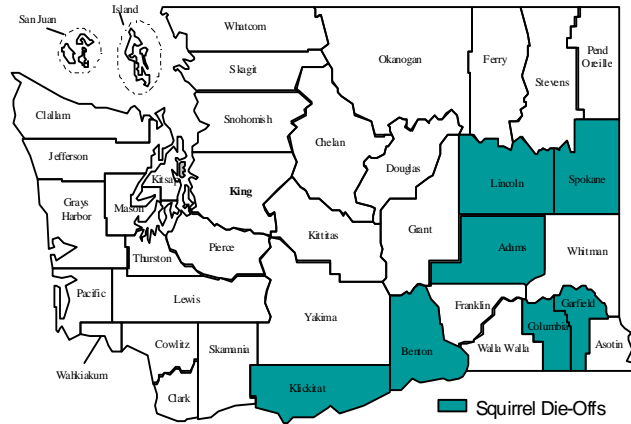
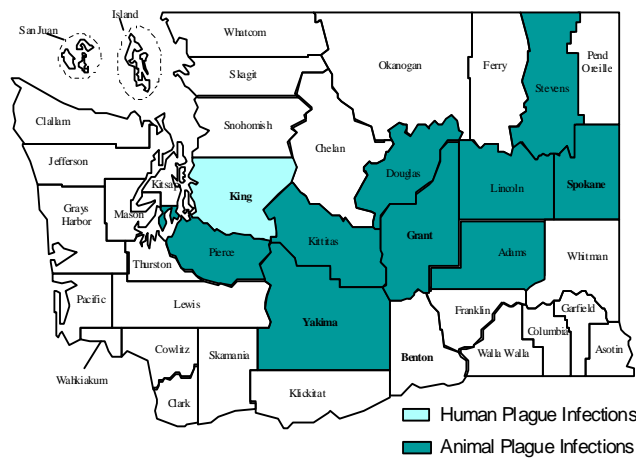


Figure 2 shows the distribution of plague infections in humans and animals by county for the years, 1907 through 1971. By 1971, evidence of plague had been found in 10 of the 39 counties of the state, mostly in eastern Washington.

Plague surveillance using serological surveys of wild carnivore populations began in 1975. Carnivore serosurveys are considered more sensitive than rodent surveys and are the recommended surveillance method

when vast areas are sampled and it is suspected that plague may have disappeared from the area.⁴ Some carnivore species that feed on plague-infected rodents, such as those belonging to the cat family, often die from infection. Wild and domestic dogs and their relatives typically survive and develop antibodies against *Y. pestis* that can be detected for up to six months. A sudden increase in seropositive carnivores indicates plague activity in the area's rodent population and serves as an early warning of increased human risk of plague infection.

Figure 2. Distribution of plague infections in humans and animals by county, 1907-1971



Since 1975, plague surveillance has identified a variety of wild carnivores as seropositive, including coyotes, bobcats, martens, badgers, mink, raccoons, cougars, and weasels. Early surveillance suggested that plague activity was limited to eastern Washington. Many of the

positive specimens were from carnivores that live in pine or fir habitats and were not associated with the sagebrush environments where previous plague foci had been. In the 1980s, the first indications of plague among carnivores west of the Cascade Range were detected. The earliest detection occurred in Thurston County in 1981.⁵ Over the following years, positive specimens were obtained from carnivores in four additional western Washington counties: Whatcom – bobcat, 1982 and coyote, 1983 and 1985; Pacific – coyote, 1983; Lewis – bobcat, 1984; and Jefferson – raccoon, 1985. The natural reservoir for plague in western Washington has not been established.

Since bobcats and coyotes are major predators of the mountain beaver, *Aplodontia rufa*, a preliminary study was proposed to determine whether this rodent could be involved in a natural plague cycle in western Washington. During the summers of 1985 and 1986, serologic and flea surveys were conducted on mountain beaver (unpublished document). All serology and flea specimens tested negative for antibodies and for the bacterium, *Y. pestis*.

Wildlife plague surveillance was discontinued in 1988 and did not resume until 1997. Since then, surveillance has been conducted annually with the exception of July 2002 through June 2003. The state's most recent positive plague specimens were detected in 2002 from two coyotes in Grant County.

Wildlife Plague Surveillance Program

Each year, the Washington State Department of Health, along with key partners, the Yakama Nation, Washington State Department of Fish and Wildlife, and Confederated Tribes of Colville, conduct serologic surveys on wild carnivores to monitor plague prevalence in the state. Specimens are collected primarily from wild carnivores using Nobuto Blood Filter Strips (Toyo Roshi Kaisha Ltd., Tokyo, Japan) and submitted to the U.S. Centers of Disease Control and Prevention, Division of Vector-borne Disease for plague serology analysis.

Surveillance for plague enables Washington State Department of Health to alert local health departments to initiate and focus control and prevention efforts in communities where elevated plague activity is detected in local wildlife. It allows for timely health advisories to health care providers and veterinarians to be vigilant for signs of the disease, and to local residents about the risk and prevention of human plague.

State coverage of plague surveillance largely depends upon surveillance partners and their collections; therefore coverage has fluctuated over the years. Historically, the majority of specimens have been collected from eastern Washington.

Between July 2007 and June 2008, serology specimens collected from 416 carnivores and 5 rodents from eight counties were tested for antibodies against *Y. pestis*. Table 1 lists the species and numbers of animals by county from which specimens were collected for plague serology analysis. Blood samples were collected primarily from coyotes (412), the vast majority (405) collected from Yakima County. Other carnivores sampled included three raccoons from Spokane County and one bobcat from Grant County. All specimens tested negative for antibodies. No plague activity was detected in Washington during this surveillance year.

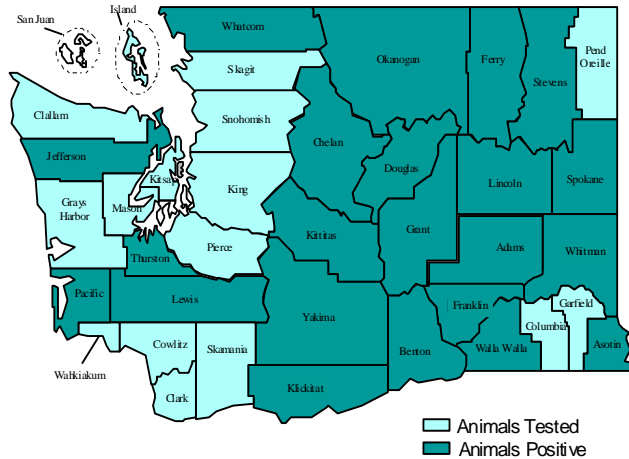
Long-term wildlife plague surveillance data indicate relatively low levels of plague activity in both eastern and western Washington. Since 2003 however, no plague activity has been detected in Washington State. Table 2 provides a year-by-year comparison of the plague specimens

submitted for testing and those that tested positive from 1975 through 2008. Plague activity has been detected in 15 of the past 21 years, with 0.5 to 13 percent of samples testing positive. Plague activity peaked at 13 percent during the 1999-2000 surveillance year. Overall, 226 (3.3 percent) of 6,781 specimens have tested positive for *Y. pestis* antibodies.

The distribution of the 6,781 plague specimens submitted for testing is, in general, statewide. With the exception of San Juan County, specimens have been collected from each county of the state. Figure 3 shows the distribution of the animals tested and those that tested positive by county from 1975 through 2008. Plague activity was detected in 22 of the 38 counties. While the majority of plague activity has occurred in eastern counties (17), positive samples have also been detected in five western counties (Jefferson, Pacific, Lewis, Thurston, and Whatcom).

Table 3 presents the number of animals tested and the percent that tested positive by county since 1975 along with the year and species of the last seropositive animal for each county. The state's last plague positive specimen was collected in 2002 from Grant County.

Figure 3. Distribution of animals tested for plague by county, 1975-2008



In summary, statewide surveillance indicates that approximately 3.3 percent of wild carnivores fed upon plague-infected rodents, and that naturally occurring plague is endemic throughout Washington. Since the early 1900s, consistent, low levels of plague activity have been detected, indicating a natural foci allowing infection to circulate among the wild rodent reservoirs. The recent absence of plague activity suggests the presence of a cyclic pattern.⁴ With continued surveillance, any sudden increases in seropositive carnivores would indicate plague activity in the area's rodent population and serve as an early warning of increased human risk of plague infection.

Table 1. Species tested for plague by county, Washington 2007-2008

| County | Bobcat | Coyote | Mouse | Raccoon | Rat | Total |
|--------------|----------|------------|----------|----------|----------|------------|
| Benton | - | 3 | - | - | - | 3 |
| Clallam | - | 1 | - | - | - | 1 |
| Ferry | - | 1 | - | - | - | 1 |
| Grant | 1 | 1 | - | - | - | 2 |
| Island | - | 1 | - | - | - | 1 |
| Klickitat | - | - | 2 | - | 3 | 5 |
| Spokane | - | - | - | 3 | - | 3 |
| Yakima | - | 405 | - | - | - | 405 |
| Total | 1 | 412 | 2 | 3 | 3 | 421 |

Note: All serology specimens from these animals tested negative.

Table 2. Animals testing seropositive for plague by year, Washington 1975-2008

| Year* | Animals Tested | Animals Positive | Percent Positive |
|---|----------------|------------------|------------------|
| 1975-1976 | 409 | 2 | 0.5 |
| 1976-1977 | 283 | 0 | 0 |
| No surveillance - July 1977 through June 1978 | | | |
| 1978-1979 | 363 | 18 | 5.0 |
| 1979-1980 | 295 | 12 | 4.1 |
| 1980-1981 | 433 | 15 | 3.5 |
| 1981-1982 | 812 | 52 | 6.4 |
| 1982-1983 | 538 | 44 | 8.2 |
| 1983-1984 | 384 | 21 | 5.5 |
| 1984-1985 | 404 | 21 | 5.2 |
| 1985-1986 | 341 | 7 | 2.1 |
| 1986-1987 | 236 | 8 | 3.4 |
| 1987-1988 | 142 | 2 | 1.4 |
| No surveillance - July 1988 through June 1997 | | | |
| 1997-1998 | 97 | 2 | 2.1 |
| 1998-1999 | 151 | 5 | 3.3 |
| 1999-2000 | 92 | 12 | 13.0 |
| 2000-2001 | 183 | 3 | 1.6 |
| 2001-2002 | 123 | 2 | 1.6 |
| No surveillance - July 2002 through June 2003 | | | |
| 2003-2004 | 153 | 0 | 0 |
| 2004-2005 | 261 | 0 | 0 |
| 2005-2006 | 257 | 0 | 0 |
| 2006-2007 | 403 | 0 | 0 |
| 2007-2008 | 421 | 0 | 0 |
| Total | 6,781 | 226 | 3.3 |

Table 3. Animals testing seropositive for plague by county, Washington 1975-2008

| County | Animals Tested | Animals Positive | Percent Positive | Last Positive Animal Year | Species |
|--------------|----------------|------------------|------------------|---------------------------|---------|
| Adams | 269 | 2 | 0.7 | 1984 | coyote |
| Asotin | 38 | 1 | 2.6 | 1979 | bobcat |
| Benton | 99 | 3 | 1.0 | 1986 | coyote |
| Chelan | 65 | 4 | 6.1 | 2000 | marten |
| Clallam | 64 | 0 | 0 | - | - |
| Clark | 14 | 0 | 0 | - | - |
| Columbia | 13 | 0 | 0 | - | - |
| Cowlitz | 64 | 0 | 0 | - | - |
| Douglas | 161 | 14 | 8.7 | 2000 | coyote |
| Ferry | 165 | 5 | 3.0 | 2000 | bobcat |
| Franklin | 237 | 3 | 1.3 | 1986 | unknown |
| Garfield | 1 | 0 | 0 | - | - |
| Grant | 215 | 10 | 4.6 | 2002 | coyote |
| Grays Harbor | 83 | 0 | 0 | - | - |
| Island | 48 | 0 | 0 | - | - |
| Jefferson | 58 | 1 | 4.6 | 1985 | raccoon |
| King | 154 | 0 | 0 | - | - |
| Kitsap | 35 | 0 | 0 | - | - |
| Kittitas | 137 | 19 | 13.9 | 1987 | coyote |
| Klickitat | 15 | 1 | 6.7 | 1984 | bobcat |
| Lewis | 50 | 1 | 2.0 | 1984 | bobcat |
| Lincoln | 503 | 40 | 7.9 | 2001 | coyote |
| Mason | 18 | 0 | 0 | - | - |
| Okanogan | 911 | 61 | 6.7 | 1999 | coyote |
| Pacific | 19 | 1 | 5.3 | 1983 | bobcat |
| Pend Oreille | 62 | 0 | 0 | - | - |
| Pierce | 46 | 0 | 0 | - | - |
| San Juan | 0 | 0 | 0 | - | - |
| Skagit | 33 | 0 | 0 | - | - |
| Skamania | 8 | 0 | 0 | - | - |
| Snohomish | 10 | 0 | 0 | - | - |
| Spokane | 95 | 1 | 1.1 | 1981 | mink |
| Stevens | 161 | 2 | 1.2 | 1982 | coyote |
| Thurston | 29 | 1 | 3.4 | 1981 | unknown |
| Wahkiakum | 11 | 0 | 0 | - | - |
| Walla Walla | 70 | 2 | 2.9 | 1998 | coyote |
| Whatcom | 184 | 3 | 1.6 | 1984 | coyote |
| Whitman | 738 | 2 | 0.3 | 1981 | coyote |
| Yakima | 1,897 | 49 | 2.5 | 2000 | coyote |
| Total | 6,781 | 226 | 3.3 | | |

Endnotes

¹ Historical accounts of plague activity found in this summary report have been obtained from reports on file with the Zoonotic Disease Program, Office of Environmental Health and Safety, Environmental Health Programs, Washington State Department of Health.

² Lewis, Robert E., et al. 1988. *The Fleas of the Pacific Northwest*. Oregon State University Press, Corvallis, Oregon. pp 45-46.

³ Sylvatic plague was not officially confirmed in Washington until 1938. However, a manuscript by Dr. S.B. Nelson from Washington State College, mentions that in the summer of 1896, an epidemic broke out among the *C. washingtoni* (*Spermophilus washingtoni*) which subsequently spread over much of their range, killing a very large proportion of them. From then on this disease, not definitely known to be sylvatic plague, occurred at different times among four species of ground squirrels in eastern Washington from 1914 to 1938.

⁴ "A characteristic of plague fundamentally important in surveillance is that it persists in natural foci within well defined geographical areas where the infective agent, vectors and reservoir hosts form an ecological association allowing the infection to circulate for infinite periods. A natural focus may become quiescent for periods of varying length that alternate with epizootic phases. Natural foci are thus completely independent of man and display a cyclic pattern of activity. The silent periods may last for over 10 years and then end with an epizootic outbreak by the findings of dead rodents and sometimes by isolated human cases of plague." Thieu L. Nghiem, Washington State Department of Health, 1977.

⁵ Previous annual summaries did not report a positive animal from Thurston County. Re-examination of historical analytical data discovered a seropositive animal, either a mink or a beaver, trapped in 1981 near McKenna, Washington.