FINAL REPORT

AVIAN AND BAT MORTALITY ASSOCIATED WITH THE INITIAL PHASE OF THE FOOTE CREEK RIM WINDPOWER PROJECT, CARBON COUNTY, WYOMING

November 1998 - June 2002

Prepared for:

Pacificorp, Inc.
Portland, Oregon

SeaWest Windpower, Inc.
San Diego, California

Bureau of Land Management
Rawlins, Wyoming

Prepared by:

WEST, Inc.

Western **E**co**S**ystems **T**echnology, Inc.
Cheyenne, Wyoming

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INTRODUCTION

An estimated 100 million to 1 billion birds die annually in the United States by colliding with manmade objects (Klem 1991). Although generally considered environmentally friendly, windpower, at most locations, has been associated with avian fatalities caused by collisions with turbines and other wind plant structures (e.g., Orloff 1992, Erickson *et al*. 2000, Erickson *et al*. 2001, Johnson *et al*. 2002). Studies conducted to date indicate that raptors and passerines appear to be the most susceptible to turbine collisions in the U.S. (AWEA 1995). At a few specific locations, such as the Altamont Pass Wind Resource Area (WRA) near Livermore, California, there have been higher levels of raptor fatalities than at other wind facilities (Orloff and Flannery 1992). However, in comparison to TV/radio and other communications towers, the number of bird mortalities in wind power facilities is thought to be relatively small (AWEA 1995, Erickson *et al.* 2001). TV/radio towers often result in episodic mortality events that may result in thousands of dead birds when inclement weather occurs during migration periods (Avery et al. 1980, Trapp 1998, Kemper 2000). Based on wind development in operation at the end of 2001, it has been estimated that wind turbines cause 0.01 to 0.02 percent (1-2 of every 10,000 fatalities) of collision-caused bird mortality in the U.S. (Erickson *et al.* 2001).

Early wind energy facilities in the U.S., such as those in the Altamont Pass, were placed without regard to factors such as avian use, and some of these sites are located where birds are abundant and the risk of turbine collisions is high (AWEA 1995). As a result, higher levels of raptor mortality have been reported there than at other wind facilities. In the Altamont Pass area, where more than 5,000 turbines exist within the WRA, Orloff and Flannery (1992) estimated 567 raptors were killed over a 2-year period from colliding with turbines. Researchers estimated 6,800 birds, primarily passerines, were killed annually at the San Gorgonio, California wind facility based on 40 dead birds found while monitoring nocturnal migrants (McCrary *et al.* 1986). The 40 dead birds were comprised of 15 passerines, seven waterfowl, two shorebirds, and one raptor. Because most of these birds were passerines and large numbers of passerines migrate through this area, it was concluded that this level of mortality was not biologically significant (Southern California Edison Company, unpublished data). Studies conducted on other wind generation facilities have not detected these levels of mortality (e.g., Erickson *et al.* 2000, Young *et al.* 2001, Johnson *et al.* 2002), and numerous factors including avian abundance, species composition, geographic area, landscape features, prey abundance, and wind plant features are believed to influence the potential for and level of avian mortality (Nelson and Curry 1995, Orloff 1992, Erickson *et al.* 2000).

Although avian mortality associated with windpower development has been of primary concern, recent studies have found that bat mortality also occurs at wind plants. Bat mortality at wind plants was first documented in Australia (Hall and Richards 1972). At a 107.25 MW wind plant on Buffalo Ridge, Minnesota, 184 dead bats were found over a four year period (Johnson *et al*. 2002). Bat mortality has also been documented at wind plants in California (Howell 1997), Oregon (Erickson *et al*. 2000), Wisconsin (Steve Ugoretz, Wisconsin DNR, pers. comm.), Colorado (Ron Ryder, Colorado State University, pers. comm.), and Wyoming (Young *et al.* 2001).

In December 1998, SeaWest completed development of a 41.4 megawatt (MW) wind plant on Foote Creek Rim (FCR) in Carbon County, Wyoming. This initial construction phase of the Foote Creek Rim wind plant (hereafter referred to as FCR I) is comprised of 69 600-kilowatt Mitsubishi turbines (41.4 MW capacity) and related facilities, including distribution lines, five meteorological (met) towers, communication system, transformers, substation, roads, and operations and maintenance facilities. Formal carcass searches to locate dead birds and bats were initiated at all turbines in November 1998, when approximately 25% of the turbines became operational. The balance of the turbines became operational shortly thereafter.

This report presents results of approximately 3.5 years (November 3, 1998 to June 5, 2002) of carcass search studies for FCR I (Turbines 1-69 and associated met towers). Subsequent construction phases II and III (FCR II, FCR III) of the wind plant development on FCR are the subject of a comparable study funded by the National Renewable Energy Laboratory (NREL) and SeaWest Windpower, Inc. Fatality searches for construction phases II -IV were initiated following completion and start-up of each phase: July 1999 for FCR II and FCR III; and November 2000 for FCR IV. Results of these additional studies are partially reported in Young *et al.* 2002.

STUDY AREA AND PROJECT DESCRIPTION

The project is located in southcentral Wyoming, in eastern Carbon County. Foote Creek Rim runs in a northerly and northeasterly direction from the foothills of the Snowy Range Mountains to approximately the town of Rock River. The Foote Creek Rim Wind Plant is located at the southern end of FCR just north of Arlington and Interstate 80. The project area is approximately 7 mi (11.2 km) long from south to north and contains a large flat mesa (Figure 1). The elevation at the south end of the mesa top is approximately 8000 ft (2435 m). FCR gradually slopes to approximately 7600 ft (2315 m) at the north end of the mesa. Land within and surrounding the wind plant is a mix of privately owned, state, and BLM land.

Habitat in the project area is primarily mixed grass prairie and sagebrush shrubland (BLM 1995). There is a band of aspen habitat along the east face of FCR, and the adjacent Rock Creek corridor is predominantly cottonwood riparian and agricultural (irrigated hay and livestock). FCR is a mesa like rim with generally steep west and east slopes and a flat top of varying width (Figure 1). Habitat on the rim top is “cushion plant” grassland (BLM 1995). As the rim progresses north it becomes somewhat broken and the slopes tend to flatten. Rock Creek parallels the rim on the east flank and Foote Creek is located to the west (Figure 1). Surrounding habitat is a mix of shortgrass and sagebrush steppe/shrubland intermixed with rocky ridges, greasewood flats, and riparian areas.

The cushion plant grassland on FCR is dominated by cushion plants (unreported species), black sagebrush (*Artemisia nova*), fringed sage (*A. frigida*), bluebunch wheatgrass (*Elymus spicatus*), western wheatgrass (*E. smithii*), and prairie junegrass (*Koeleria macrantha*) (BLM 1995). The sagebrush steppe/shrubland varies with location but is primarily either stands of big sagebrush (*Artemisia tridentata*) or black sagebrush (*A. nova*) with common range grasses and forbs such as junegrass, blue gramma (*Bouteloua gracilis*), needlegrass (*Stipa comata*), western wheatgrass, aster

(*Aster spp.*), yarrow (*Achillea milleflium*), buckwheat (*Eriogonum umbellatum*), paintbrush (*Castilleja spp.*), pussy-toes (*Antennaria spp.*), and prickly pear (*Opuntia polyacantha*).

The FCR I construction units was completed in the fall of 1998 and included 69 turbines and 5 met towers located on the southern half of the rim. Construction of FCR I unit began in the summer of 1997 with the facility roads and plant headquarters/maintenance facilities. Turbine pads for FCR I were built in the fall 1997 and spring 1998 with actual turbine construction beginning in the summer of 1998. Turbine commissioning for FCR I began in August 1998 with all turbines operational by the end of December 1998.

The FCR I wind plant total project area is approximately 2,090 acres. This includes the mesa top and some of the adjoining slopes. Total permanent ground disturbance for the roads, turbine pads, and substation equaled approximately 26.6 acres and there is approximately 5.2 miles of road within FCR I. The Mitsubishi turbines in FCR I are approximately 131 ft (40 m) tall at the nacelle with a rotor diameter of 138 ft (42 m). Tower (turbine) spacing in FCR I is approximately 276 ft (84 m). The permanent met towers in the wind plant are approximately 125 ft (38 m) in height and are held up by 3 sets of 3 guy wires set at 120^{o} angles around the tower. Areas disturbed during construction activities were re-seeded with a seed mix designated in the plan of development (POD) of grasses native to the area (TRC 1997).

Currently, work on the rim consists of normal operation and maintenance (O&M) activities; there is no active construction. Standard best management practices are employed for the site (construction and O&M). Vehicular traffic is confined to the new roads, construction and O&M crews are housed off site, and domestic dogs and other pets are not allowed on site. In addition to construction and wind plant operation activity, wildlife monitoring activities took place on the rim between 1995 and 2000. Future activities on the rim will include O&M and may include conduct of some wildlife monitoring studies - fatality searches and mountain plover studies.

METHODS

Carcass Searches

The objective of the carcass searches was to estimate the number of avian and bat fatalities attributable to wind turbines and met towers in FCR I. Mortality was measured by estimating the number of bird and bat carcasses in the wind development area whose death could be related to turbines, met towers, or other wind plant features. All avian and bat carcasses located within areas surveyed, regardless of species, were recorded and a cause of death determined, if possible, based on field examination. An estimate of the total number of carcasses was made by adjusting for removal bias (affected by scavenging) and searcher efficiency bias (affected by detection).

Carcass searches were conducted at half of the turbines and met towers once every two weeks during the study period from November 1998 - December 2000. All turbines and met towers were searched once each 28 day period during this time frame. From June 2001 to June 2002, one-half of all turbines and all the met towers were searched once every 28 day period. Biologists trained in proper search techniques conducted the searches. Data collected by Orloff and Flannery (1992), Higgins *et al*. (1996), Johnson *et al*. (2002), as well as other windpower researchers have indicated that most birds and bats killed by striking turbines remain within 63 m of the turbine. Permanent rectangular plots 126 m in width were centered on each of the six turbine strings in FCR I to ensure all areas within 63 m of each turbine were searched. For searching met towers, a 126×126 m square plot was centered around each tower. Square or rectangular plots were used instead of circular plots to facilitate marking search boundaries and conducting the search. The number of turbines included within a search string ranged from 6 to 10 (Figure 1). Between June 2001 and June 2002, the number of turbines included in a search string was reduced to 3-4 turbines so that greater spatial coverage of the wind plant could be gained when only searching half of the turbines.

Search transects were set approximately 8-10 m apart in the area searched, and the searcher walked at a rate of approximately 45-55 meters per minute (m/min) along a transect searching both sides for casualties out to approximately 4-5 m. On average, approximately 45 minutes were spent searching each turbine or met tower per search. Carcasses found incidentally while conducting other study activities were also recorded.

For each casualty, data recorded included species, sex and age when possible, date and time collected, location, condition, and any comments that may have indicated time and cause of death. The condition of each casualty found was recorded using the following condition categories:

- Intact - a carcass that is completely intact, is not badly decomposed, and shows little or no sign of being fed upon by a predator or scavenger;
- Scavenged - an entire carcass showing signs of being fed upon by a predator or scavenger or a dismembered carcass (portions) in one location (e.g., wings, skeletal remains, legs, pieces of skin, etc.);
- Feather Spot - ten or more feathers at one location indicating predation or scavenging. If only feathers are found, 10 or more total feathers or 2 or more primaries must be discovered to consider the observation a casualty.

All carcasses located were photographed as found and mapped on a detailed map of the study area. Carcasses were labeled with a unique number, bagged and frozen for future reference and possible necropsy. The U.S. Fish and Wildlife Service (USFWS) Special Agent in Casper, Wyoming was notified by telephone and/or email of all casualties found and was contacted within 24 hours to report any raptors or other species of concern. The Wyoming Game and Fish Department (WGFD) and Bureau of Land Management (BLM) were also informed of any raptors within 24 hours and periodically notified of other casualties found. Carcass searches were not conducted on reference plots and no estimates of background mortality on FCR I are available. Therefore, all carcasses and carcass parts found near turbines or met towers where the cause of death was not apparent were considered wind plant related, which insures a conservative (over) estimate of wind plant related casualties.

The mean number of carcasses detected per search period was calculated by:

$$\bar{c} = \frac{\sum_{i=1}^{k} c_i}{k}$$

where c_i is the number of carcasses detected during the i^{th} search at turbine i for the period of study, and k is the number of search periods. The variance was calculated by:

$$V(\bar{t}) = \frac{1}{k} \times \left[\frac{\sum_{i=1}^{k} (c_i - \bar{c})^2}{k-1} \right]$$

The total number of carcasses (C) was calculated by:

$$C = k \times \bar{c}$$

with variance:

$$Var(C) = k^2 \times var(\bar{c})$$

Carcass Search Biases

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of avian carcasses found (detected) by searchers. Searcher efficiency studies were conducted in the same areas carcass searches occurred. Estimates of searcher efficiency, the carcass detection rate, were used to adjust the carcasses counts for searcher bias.

For each trial, 15 "detection" carcasses of birds of three different size classes (small, medium, large) were placed in the search area before the search period for a searcher to either detect or not detect. Adult female mallards were used to represent large birds such as raptors and waterfowl; adult rock doves were used to simulate medium sized birds such as small raptors and shorebirds; and adult house sparrows and juvenile coturnix quail were used to represent small birds such as passerines. Whole carcasses as well as body parts (e.g., wings) were used in the searcher efficiency trials. Each carcass/carcass part was discreetly marked (e.g., a piece of dull colored electrical tape wrapped around the leg) so that it could be identified as a study carcass after it was found.

Personnel conducting searches did not know the location of the searcher efficiency carcasses or when carcasses would be placed. All carcasses were placed at random locations within areas being searched prior to the carcass search on the same day. Carcass placement was spread over the entire season to incorporate effects of varying weather, vegetation growth, and searchers but always occurred on a carcass search day.

The number and location of the detection carcasses/carcass parts found during the carcass search were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial. Carcasses/carcass parts not found by the searcher were removed following the carcass search effort for that day.

Searcher efficiency was expressed as *p*, the proportion of detection carcasses found by searchers. Results of searcher efficiency trials were used to evaluate effectiveness of the carcass search effort and to make adjustments for the final estimate of the total number of carcasses. The variance, *V(p)*, was calculated by the formula:

$$V(p) = \frac{p(1-p)}{n}$$

where *n* is the total number of carcasses placed. A different searcher efficiency rate was estimated for each season and carcass size class.

Carcass Removal

The objective of the carcass removal trials was to estimate the length of time avian carcasses remain in the search area prior to being removed. Carcass removal from the possibility of detection includes removal by predators, scavengers, or other means. Carcass removal trials were conducted in the same areas where carcass searches occurred during each of the following seasons: spring migration (February 15 - April 15), summer breeding season (April 16 - August 31), fall migration (September 1 - October 31), and winter (November 1 - February 14).

Each trial consisted of monitoring the fate of 10 birds of varying composition. Carcasses used for carcass removal were of the same composition as those used for searcher efficiency trials (i.e., small, medium, large) to represent a variety of avian species and size classes. Carcasses were placed randomly within the search areas. To minimize the possibility of attracting scavengers to the area and to preserve independence of data, no more than one carcass was placed in a plot.

Trials were conducted approximately twice each season to incorporate effects of varying weather, vegetation conditions, and scavenger densities. Carcasses were checked over a period of 28 days to determine removal rates. Carcasses were typically checked every day for the first 4 days, and on days 7, 10, 14, 18, 23, and 28 with some variations to this schedule when necessary. At the end of the 28-day period all remaining carcasses or evidence of the carcasses were removed. Carcasses were discreetly marked (similar to searcher efficiency carcasses) so that searchers and other personnel could recognize the carcass as experimental and leave it at the location found.

Estimates of carcass removal (length of stay) were used to adjust carcass counts for removal bias. Mean length of time (days) a carcass remained at the site before it was removed ($\bar{t}$) was calculated by:

$$\bar{t} = \frac{\sum_{i=1}^{k} t_i}{k}$$

where t_i is the length of time a carcass remained in the study area before it was removed and k is the number of carcasses where t_i was obtained. The variance, $V(\bar{t})$, was calculated using the usual variance of a mean formula:

$$V(\bar{t}) = \frac{1}{k} \cdot \left[\frac{\sum_{i=1}^{k} (t_i - \bar{t})^2}{k-1} \right]$$

Carcass removal statistics were calculated for each size class of bird by season. Because a substantial number of birds remained in the study area at the end of 28 days, the average length of time, $\bar{t}$, was estimated by statistical methods appropriate for censured data (Shumway 1989).

Estimation of the Total Number of Fatalities

The estimate of the total number of fatalities consists of three components: (1) the estimate and associated variance for the number of carcasses detected during the study period, (2) the estimate and associated variance for the mean length of time carcasses remain in the study area, and (3) the estimate and associated variance for the percentage of carcasses found by searchers. Values used for the searcher efficiency rate and mean length of stay were averaged across seasons for calculating the number of fatalities within the wind plant for the entire study period.

The estimated total number of fatalities for the wind plant, m, for the time frame between searches was calculated by:

$$m = \frac{N \cdot I \cdot C}{k \cdot \bar{t} \cdot p}$$

where N is the total number of turbines or met towers, I is the interval between searches in days, C is the total number of carcasses found for the period of study, k is the number of turbines or met towers sampled, t is the mean length of time carcasses remain in the study area before being removed, and p is the searcher efficiency.

The variance was calculated using the variance of a product formula (Goodman 1960) and the variance of a ratio formula (Cochran 1977). The variance of the product *t* and *p* is:

$$V(\bar{t} \cdot p) = \bar{t}^2 \cdot V(p) + p^2 \cdot V(\bar{t}) - V(\bar{t}) \cdot V(p)$$

From this, the variance of *m* is approximated by:

$$V(m) = \frac{N^2}{n^2} \cdot I^2 \cdot m^2 \cdot \left[\frac{V(\bar{t} \cdot p)}{\bar{t}^2 \cdot \bar{p}^2} + \frac{V(\bar{c})}{\bar{c}^2} \right]$$

The standard error of *m* is approximated by:

$$SE(m) = \sqrt{Var(m)}$$

An approximate 90% confidence interval around *m* is:

$$m \pm 1.67 \cdot SE(m)$$

Relationships between Physical Factors and Fatality Rates

Selection ratios were used to investigate whether correlations exist between the characteristics of the turbines and their locations and the number of fatalities observed. The selection ratio was calculated by:

$$\hat{w}_i = f_i / t_i$$

where f_i is the percentage of fatalities in category i and t_i is the percentage of turbines in category i. This selection ratio gives the relative probability a fatality will occur at a unit classified as category i. For example, the categories could be end row turbine versus mid-row turbine, and the selection ratio gives the relative probability a fatality is likely to occur at an end row turbine compared to a mid-row turbine.

Selection ratios are often standardized so that they add to 1, leading to Manly's standardized selection ratio:

$$B_i = \hat{w}_i / \left(\sum_{i=1}^{I} \hat{w}_j \right),$$

B_i can be interpreted as the probability (or risk) that a fatality will occur at a unit (turbine, met tower) classified as category i.

RESULTS

Avian Fatalities

Three avian fatalities were located on the FCR I wind plant in September and October 1998 prior to initiation of formal carcass searches on November 3, 1998 (Appendix A). During formal carcass searches from November 3, 1998 to October 31, 1999, 56 avian casualties were located. Between November 1, 1999 and December 31, 2000, 37 avian casualties were found. Between June 1, 2001 and June 5, 2002, 26 avian casualties were found. The 122 total avian casualties were comprised of at least 37 species. Eighty-three (83) of the carcasses were found associated with turbines, 36 were associated with met towers, and three were unknown due to the carcasses' distance from wind plant facilities[1] (Appendix A).

One-hundred and twelve (92%) of the casualties found were passerines. The most common passerine found was horned lark (32). Other passerine species with two or more fatalities found were vesper sparrow (8), chipping sparrow (6), Brewer's sparrow (6), rock wren (4), house wren (4), Wilson's warbler (4), American robin (3), Townsend's warbler (3), green-tailed towhee (3), white-crowned sparrow (2), mountain bluebird (2), Lincoln's sparrow (2), cliff swallow (2), and brown creeper (2) (Appendix A). Non-passerine birds found included American kestrel (3), northern harrier (1), short-eared owl (1), western grebe (1), lesser scaup (1), mourning dove (1), common poorwill (1), and common nighthawk (1) (Appendix A).

Fifty-six (46%) of the casualties were intact, 51 (42%) were scavenged, 14 (11%) were feather spots, and one (1%) was an injured bird. One-hundred and three (84%) of the casualties were found during scheduled carcass searches and the remaining 19 (16%) were found incidentally while conducting other study activities.

Of the 122 total carcasses found, 117 were used in the estimates of fatalities per structure[2] per year and total wind plant mortality. The five carcasses excluded from the analyzes included the three carcasses found prior to initiating formal carcass searches and two flightless juvenile horned larks which were likely scavenged/predated from a nest and not wind plant related fatalities.

At turbine plots, avian casualties were located between 4 and 77 m from the turbines with an average distance of 37.7 m. Using the bird fatalities included in the turbine fatality estimates (81), avian casualties were found in 46 of the 69 turbine plots (Figure 2). The largest number of birds found at any one turbine was five (turbine 22). Four birds were found at two different turbines (turbines 65 and 69). The largest number of avian casualties found at any one turbine during any one search was two which occurred twice (turbines 28 and 65).

[1] The carcasses found at distances too great to determine if they were associated with a wind plant turbine or met tower were all found incidentally during other wildlife studies (e.g., raptor point counts).

[2] Meteorological tower or turbine

At met towers, avian casualties were found between 3 and 50 m from the towers with the average distance 23.0 m. Avian casualties were found at all five met tower plots. Using the bird fatalities included in the met tower fatality estimates (33), the highest number of casualties (17 birds[3]) occurred at met tower 202 (Figure 2). The largest number of avian casualties found at any one met tower during any one search was four which occurred at met tower 1 (5/13/99). On three different occasions (9/13/99, 8/29/01, 5/14/02), three fatalities were located at met tower 202 during one search.

Casualty data suggest that migrant and resident birds are susceptible to turbine or met tower collisions on FCR I. Based on species and date each casualty was found, 64 of the 122 total birds (52%) were possible migrants through the area. The remaining 58 birds were likely residents/breeders in the area. Very few fatalities were found during the winter season (Figure 3). Many of the species found dead while carcass searching have never been observed on top of the rim during daytime avian surveys (see Johnson *et al*. 2000), including short-eared owl, western grebe, lesser scaup, Wilson's warbler, MacGillivray's warbler, Townsend's warbler, yellow-rumped warbler, black-throated blue warbler, warbling vireo, house wren, brown creeper, lark bunting, dark-eyed junco, green-tailed towhee, white-crowned sparrow, Lincoln's sparrow, hermit thrush, ruby-crowned kinglet, American pipit, and western tanager. Although many of these species may breed in aspen habitats on the east side of FCR and have been observed there during avian surveys, many of the fatalities occurred during spring or fall migration periods, not during the breeding season (see Appendix A).

Bat Fatalities

Forty-seven dead bats were found during the first year[4], 18 dead bats during the second, and 14 dead bats during the third year of carcass searches. All bat casualties were associated with turbines; no dead bats were found at met towers. Sixty-three (79.7%) of the bat casualties were hoary bats. The remaining bats consisted of little brown bats (7), silver-haired bat (6), big brown bat (1), and two bats that were too decomposed for positive identification. Bat casualties were found primarily during the period from June to September in all years, with most of the bats were found in the month of August (Figure 2, Appendix B). Seventy-one of the 79 bats (89.9%) were found during scheduled carcass searches; the other eight were found incidentally while conducting other study activities.

All bat carcasses found were used to estimate fatalities per turbine per year and total wind plant mortality. Bats were found at 48 of the 69 turbine plots searched (Figure 1). The largest number of bats found at any one turbine was four (turbines 40, 44, and 47). The largest number of bat casualties found at any one turbine during any one search was three which occurred twice on 8/31/99 (turbines 18 and 32).

[3] Three of the 20 bird fatalities at met tower 202 were found prior to initiating formal carcasses searches.

[4] Two bat carcasses found during the winter season (1999-2000) were very old and had obviously died during 1999. These carcasses and were included in the data for 1999.

Sixty-three of the bats (79.7%) were intact, 11 (14.0%) were scavenged, and five (6.3%) were dismembered. Most of the scavenging appeared to have been the result of insects, however, there was other evidence of small mammal scavenging and one bat was found in the mouth of a ground squirrel hole. Distances bats were found from turbines ranged from 8 m to 86 m, with the mean distance 27.4 m.

No field data on habitat use or behavior of bats in the FCR I study area was collected for this study. Hoary bats roost in deciduous trees. Little brown and big brown bats also roost in trees, but may roost in other habitats including rock crevices, wood piles, buildings, bridges, and other structures (Clark and Stromberg 1987). Silver-haired bats are known to roost in trees in foliage, hollow trunks, and under loose bark, but will also use mines, caves, and buildings. Bat roost sites in the project area likely include aspen stands on the east side of FCR, cottonwoods and aspen associated with the Rock Creek riparian zone east of FCR, and possibly cottonwood trees and abandoned buildings along Foote Creek west of FCR. Hoary and silver-haired bats are migratory species. Hoary bats and silver-haired bats migrate north in May and June, and begin their southward movement in August or early September (Fitzgerald *et al*. 1994). Both the little and big brown bat spend the winter in hibernacula, and may migrate up to several hundred miles to hibernate. According to Fitzgerald *et al*. (1994), hoary bats typically forage from treetop level to within a meter of the ground; however, Clark and Stromberg (1987) report that these bats may circle to high altitudes while feeding. Little and big brown bats generally forage at heights of 1.5 to 6 m near or over water. Silver haired bats appear to prefer forest edges and will forage over open areas, streams, and ponds. They are thought to be a low level flier from the ground up to 6 m in height (Fitzgerald *et al.* 1994)

Carcass Search Biases

<u>Searcher Efficiency</u>

Over the first two years of study, 462 avian carcasses were used in searcher efficiency trials during the study (Table 1). Overall, searcher efficiency varied by size class of bird; 59% of the small birds, 87% of the medium sized birds, and 92% of the large birds were detected. The overall detection rate for all bird size classes combined was 80% (Table 1). Searcher efficiency was similar among seasons, averaging 79% in the spring, 80% in summer, 84% in fall, and 78% in winter.

Fifteen of the hoary bat carcasses found in 1999 which were fresh and intact were retained for searcher efficiency and carcass removal trials the following year. During the summer 2000 season, 16 hoary bats (some used more than once) were placed in the field for searcher efficiency trials. The mean detection rate for bats was 63%, similar to the overall mean detection rate for small birds in the summer (62%) (Table 2).

<u>Carcass Removal</u>

During the first two years of study, 260 avian carcasses were used for scavenger removal trials (Table 2). The mean length of time that carcasses remained in the study area prior to removal varied with carcass size and season. For all seasons combined, medium-sized birds lasted the longest (37 days), followed by large birds (29 days) and small birds (13 days) (Table 2). Mean length of stay for all size classes of birds combined was longest in the summer (42 days), followed by fall (26 days), spring (25 days) and winter (21 days). The overall mean length of stay for all carcasses and seasons was 29 days. Species observed in the project area that may scavenge carcasses include raptors, ravens, crows, magpies, coyotes, red foxes, badgers, white-tailed prairie dogs, ground squirrels, deer mice, and insects. During summer, one of the main causes of carcass removal was scavenging by insects, including beetles, ants, and maggots. Throughout the remainder of the year, either ground squirrels and/or deer mice appeared to be the primary scavengers of carcasses. During the fall and winter, common ravens were periodically observed foraging on trial carcasses.

During the summer 2000 season, ten hoary bat carcasses were placed in the field and monitored for scavenging. The mean length of stay for the hoary bats was approximately 20 days (Table 2).

Estimation of Wind Plant Related Mortality

Searcher efficiency and scavenging rate (length of stay) data were pooled across seasons for calculating total avian and bat mortality. Scavenging rate and searcher efficiency data collected for small birds were used to estimate bat mortality in 1999. In 2000, scavenging and searcher efficiency data for bats was used to estimate bat mortality. Estimates for scavenging rate and searcher efficiency for bats from 2000 were used for bat mortality estimates in 2001-2002. Estimates for scavenging rate and searcher efficiency for birds from 1999 and 2000 were used for bird mortality estimates in 2001-2002.

Using corrections for searcher and scavenger bias, the estimated total number of turbine-related casualties for 1999 [Nov 3, 1998 - Oct 31, 1999] for FCR I was 141 birds and 165 bats; for 2000 [Nov 1, 1999 - Dec 31, 2000] the estimate was 100 birds and 40 bats; and for 2001-2002 [June 1, 2001 - June 5, 2002] the estimate was 80 birds and 90 bats (Tables 3 and 4). Combining all years of data, the estimated total annual turbine related casualties was 103 birds (90% CI= 67 - 140) and 90 bats (90% CI = 30-150).

The estimated mortality rate per year was estimated to be 2.04 birds/turbine and 2.38 bats/turbine for 1999; 1.45 birds/turbine and 0.63 bats/turbine for 2000; and 1.16 birds/turbine and 0.94 bats/turbine for 2001-2002 (Tables 3 and 4). For all years combined, the annual estimated mortality per turbine is 1.50 birds/turbine (90% CI = 0.93 - 2.08) and 1.34 bats/turbine (90% CI = 0.20- 2.43).

The total number of avian casualties associated with the five met towers within FCR I was estimated to be 63 birds in 1999; 13 birds in 2000; and 46 birds in 2001-2002. Combining all years, the total annual estimate is 40 birds (90% CI = 20 - 55) (Table 3). The estimated avian mortality rate per met tower per year was 12.50 birds/tower in 1999; 2.53 birds/tower in 2000; and 9.23 birds/tower in 2001-2002. For all years combined, the annual estimate was 8.09 birds/tower (90% CI = 5.03 - 11.14) (Table 3).

Fatality Locations

Several univariate analyses were conducted to compare relative risk of collision between levels of factors such as turbine location (end row versus mid-row), structure type (met tower versus turbine), and proximity of turbine to rim edge (east edge versus west edge). Selection ratios and standardized selection ratios were used to compare the relative risk of collision between levels of these factors.

Standardized selection ratios for mid-row turbines was slightly higher (0.63 verus 0.37), suggesting, on a per turbine basis, a slightly higher probability of risk of collision with a mid-row turbine compared to an end row turbine (Table 5). Standardized selection ratios for meteorological towers were much higher (0.85 verus 0.15), suggesting, on a per structure basis, a much higher probability of risk of collision with individual met tower compared to a individual turbine (Table 5).

Factors such as distance from rim edge to turbine and rim width did not appear associated with probability of fatality occurrence. The mean distance to rim edge for turbines with fatalities was 418 m and the mean distance to rim edge for turbines without fatalities was 370 m. In addition the rim width at turbines with and without fatalities was also very similar, 1400 m and 1429 m respectively. Distance to rim edge and rim width for turbines with no or 1 fatality reported (381 m and 1449 m) compared with turbines with multiple fatalities reported (446 m and 1327 m) were also similar. Individual turbines closest to the west rim edge appeared to pose higher risk of collision than individual turbines closest to the east rim edge (Table 6) but the difference was not significant.

DISCUSSION AND CONCLUSIONS

Searcher Efficiency and Scavenger Rate Corrections

Estimates of overall bird mortality were highest in 1999, and lowest in 2001-02, but none of the differences were statistically significant ($p > 0.20$). Annual estimates varied only from 2.04 bird fatalities per turbine per year in 1999 to approximately 1.16 bird fatalities per turbine per year in 2001/2002. These estimates contain adjustments for searcher detection biases and scavenging biases.

Searcher efficiency rates at Foote Creek Rim were similar in both years it was estimated (1999 and 2000). Searcher efficiency estimates were approximately 90% for medium and large birds and approximately 60% for small birds both years (Table 1). These estimates would be considered high compared to several other wind projects studied (see Erickson *et al.* 2000, Johnson *et al.* 2002, Morrison 2002). The short grass habitat on Foote Creek Rim provides very good searcher visibility due to the low vegetation height and prevalence of bare ground, while the studies at Buffalo Ridge, Minnesota (Johnson *et al.* 2002) and Vansycle, Oregon (Erickson *et al.* 2000) were located in agricultural habitats with variable and fast growing vegetation.

Scavenging rates also remained similar over the two years of study (Table 2), although there was a drop in the mean removal time for large birds in the winter of 2000. This was thought to be primarily due to ravens that were commonly observed feeding on the mallard carcasses used in the trials. Scavenging rates during this study for small and large birds (13 days and 29 days) were higher than at Buffalo Ridge, Minnesota (. 5 and . 9 days) and closer to Vansycle, Oregon (. 23 and . 27 days). Scavenging appeared much higher at Altamont Pass, with 50% loss in three days during one study (Howell and Didonate 1991). Scavenging rates documented at some studies of communications towers are even higher (Crawford 1971). At a TV tower in Florida, only 7% of the fatalities were left undisturbed after a 24 hour period. The high scavenging rates documented at some communication towers may be related to the apparently consistent source of food for scavengers. While at wind plants, the low level of mortality spread out across a larger area and across time (i.e., no large concentrations or events), creates a less consistent resource for scavengers. Scavenging rates should be considered when designing a fatality study, and the search interval adjusted appropriately if scavenging rates are high and length of stay for dead birds is short.

Sources of Bias

Estimates obtained from this study, and other similarly designed fatality studies, may be affected by various sources of bias. For example, (1) measured scavenging and searcher efficiency rates may not accurately reflect true rates, (2) fatalities due to other sources may be attributed to the wind plant, and/or (3) all carcasses may not fall or remain in the search area.

The experiments used to estimate scavenging and searcher efficiency bias may not accurately mimic true fatalities. The species of bird used in the experiments may be scavenged at higher or lower rates than actual fatalities. For example, chickens were used in scavenging trials at Tehachapi Pass and San Gorgonio Pass (Anderson *et al.* 2000) because of convenience (no state or federal permits requirements and chickens were readily available). It is suspected that chickens may be scavenged at a higher rate than raptors, the group of birds that were a focus of the fatality studies. If it is assumed that scavenging rates using chickens are overestimated (i.e., length of stay is shorter), a potential positive bias in fatality rates for raptors is introduced (i.e., the removal rate for raptors is overestimated). Similarly to chickens, hen mallards, rock doves, and coturnix quail (used in this study) may be scavenged at a higher rate than native raptors or sparrows.

In this and other similar studies (e.g., Erickson *et al.* 2000, Johnson *et al.* 2002), intact and scavenged caracsses, and feather spots were included in the estimation of wind turbine related fatalities. This leads to an overestimate of true mortality due to the wind turbines. It is assumed that some of the fatalities located during the study were due to other sources (e.g., natural predation), however, no background estimates of mortality for the site were made so no corrections to the data could be made. Background mortality at FCR may be particularly high due to the high raptor use estimates of the project area (see Johnson *et al.* 2000). It is presumed that raptors in the project area are actively hunting and species such as prairie falcon may be frequently killing small birds on FCR. Obtaining reference mortality estimates can provide a means for estimating the portion of the fatalities that are not wind plant related. Reference mortality estimates based on carcass searches of plots in agricultural and CRP fields near the Buffalo Ridge Wind Project, Minnesota were approximately 1/3 of the estimates obtained at the wind turbines (Johnson *et al.* 2002). Costs associated with obtaining these reference mortality estimates have precluded their widespread use during studies at most wind projects.

Searches were conducted within rectangular plots with boundaries a minimum of 63 m from turbines. This distance was selected based on the distribution of fatalities associated with turbines in California, Oregon, and Minnesota. However, some wind turbine related fatalities and injured birds may have fallen or been moved to outside this area and particularly when winds are very high or scavenging rates are high. In this case the mean distance for bird carcasses from the turbine was 37.7 m and for bats 27.4 m. These means are close to half the distance searched and the number of carcasses that actually fall (or end up) outside the search area is expected to make up only a small proportion of the total fatalities. It is recommended, however, that as turbines increase in size, the area that is searched should be increased as well.

Raptor and All Bird/Bat Mortality

The large majority (92%) of wind plant-related avian casualties in FCR I were passerines, and slightly more than half of these, based on species and date found, were probably nocturnal migrants. The number of raptor casualties was very low during the study period despite high raptor use estimates for the site. For example, no golden eagle carcasses were located during the study, despite the high golden eagle use of the area, approximately 40% of all raptor use (see Young *et al.* 2002). In contrast, American kestrels comprised approximately 5% of the raptors observed, but accounted for 60% of the raptor carcasses found. Due to the low scavenger removal rate and high searcher efficiency for medium and large carcasses, it is likely that the three American kestrels, one northern harrier, and one short-eared owl found were the only raptors killed in FCR I during the study period. The western grebe and lesser scaup were also likely the only other medium or large sized bird fatalities during the study period.

Raptor mortality has been virtually non-existence at some other new generation wind projects (see Erickson *et al.* 2001). For example, no raptors were found during one year of searches at the Vansycle Wind Plant and only one red-tailed hawk was found during five years of phased searches at Buffalo Ridge, Minnesota. Raptor use estimates for these wind plants were much lower than at FCR. Data collected during the first three years of operation of FCR I indicate that raptor mortality is still relatively low despite the higher raptor use. The estimate of 0.03 raptor fatalities per turbine per year is lower than most raptor mortality estimates reported in California at Altamont and Montezuma Hills (Erickson *et al.* 2001). Furthermore, the turbines at FCR I have a rotor swept area approximately 5 times larger than the average rotor swept area of turbines at Altamont[5]. By standardizing estimates for every 100,000 square meter of rotor swept area, Altamont estimates (9-22 raptor fatalities/100,000 m^2 RSA) are approximately 3-7 times higher than at FCR (3 raptor fatalities/100,000 m^2 RSA) based on the mortality estimates from Orloff and Flannery (1992).

Overall avian fatality rates in FCR I (1.5 bird fatalities/turbine/ear, 108 bird fatalities/100,000 m^2 RSA/year) are lower than those found on Buffalo Ridge, Minnesota [2.8 bird fatalities/turbine/year; 161 bird fatalities/100,000 m^2 RSA/year (Johnson *et al*. 2002)], however, higher than the one-year estimate at Vansycle Wind Project [0.63 birds fatalities/turbine/year, 38 bird fatalities/100,000 m^2 RSA/year (Erickson *et al.* 2001)]. The estimated number of bats killed per turbine at FCR I (1.34

[5] Foote Creek Rim turbines average approximately 1500 m^2 RSA. It was assumed Altamont turbines average approximately 300-400 m^2 RSA due to variety of smaller older-generation turbine types and sizes.

bat fatalities/turbine/year, 97 bat fatalities/100,000 m^2 RSA/year) is also lower than the Buffalo Ridge wind plant (2.3 bat fatalities/turbine/year, 164 bat fatalities/100,000 m^2 RSA/year), and higher than the one-year estimate (0.74 bat fatalities/turbine/year, 45 bat fatalities/100,000 m^2 RSA/year) from the Vansycle Wind Project, Oregon.

It has been suggested that birds may be more at risk of collision with wind turbines during periods of inclement weather. During this study, for casualties estimated to have been dead for less than a week, weather conditions that were known to have occurred during the week prior were noted. No strong correlations of avian or bat casualties with weather events were noted. Of the 122 avian casualties found during the study, 77 were estimated to have been dead for less than one week. Forty-five of the 77 casualties (58%) possibly occurred in association with precipitation events including rain and snow or combinations of rain and snow. Twelve avian casualties (16%) occurred when inclement weather was not known for the week prior to finding the casualty. Twenty-six of the 79 bats found were estimated to have been dead for less than one week. Of theses, 17 (65%) may have died during some form of precipitation event such as combinations of rain, fog and snow. Correlating fatalities to weather events in this study was simply a best guess, since the actual time of the death is unknown. Casualty searches on a much more frequent basis would be need to better determine time of death. However, in an environment where scavenging is low and searcher efficiency high, daily or even weekly searches are not necessary to accurately estimate wind plant related mortality.

Overall results of the three years of carcass search studies indicate that the monitoring protocol used for this study was sufficient to provide data adequate to evaluate direct effects of windpower development on avian and bat resources. It also indicates fairly similar mortality across years, indicating the average estimates for the three years should be reasonably accurate for predicting future mortality. The extent of study for FCR I (approximately 3 years of continuous data) has become one of the bench marks by which potential effects from proposed new wind plants are being evaluated.

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Table 1. Number of birds detected during searcher efficiency trials

1999 Size Class of Bird	Season [November , 1998 - October 31, 1999] Spring	 Summer	 Fall	 Winter	Total
Small	14/23 (61%)	8/16 (50%)	11/15 (73%)	9/20(45%)	42/74 (57%)
Medium	23/28 (82%)	23/27 (85%)	23/28 (82%)	20/20 (100%)	89/103 (86%)
Large	21/23 (91%)	22/25 (88%)	17/17 (100%)	18/20 (90%)	78/85 (92%)
Total	58/74 (78%)	53/68 (78%)	51/60 (85%)	47/60 (78%)	209/262 (80%)

2000 Size Class of Bird	Season [December 1, 1999 - December 31, 2000] Spring	 Summer	 Fall	 Winter	Total
Small	6/10 (60%)	18/26 (69%)	4/7 (57%)	11/20 (55%)	39/63 (62%)
Medium	8/9 (89%)	25/26 (96%)	6/7 (86%)	16/20 (80%)	55/62 (89%)
Large	10/11 (91%)	21/23 (91%)	7/7 (100%)	19/20 (95%)	57/61 (93%)
Subtotal	24/30 (80%)	64/75 (85%)	17/21 (81%)	46/60 (77%)	151/186 (81%)
Bats (Small)		10/16 (63%)			10/16 (67%)
Total	24/30 (80%)	74/91 (81%)	17/21 (81%)	46/60 (77%)	161/202 (80%)

1999-2000 Size Class of Bird	Season [November 1, 1998 - December 31, 2000] Spring	 Summer	 Fall	 Winter	Total
Small	20/33 (61%)	26/42 (62%)	15/22 (68%)	20/40 (50%)	81/137 (59%)
Medium	31/37 (84%)	48/53 (91%)	29/35 (83%)	36/40 (90%)	144/165 (87%)
Large	31/34 (91%)	43/48 (90%)	24/24 (100%)	37/40 (93%)	135/146 (92%)
Subtotal	82/104 (79%)	117/143 (82%)	68/81 (84%)	93/120 (78%)	360/448 (80%)
Bats (Small)		10/16 (63%)			10/16 (67%)
Total	82/104 (79%)	127/159 (80%)	68/81 (84%)	93/120 (78%)	370/464 (80%)

Table 2. Estimated mean length of stay for carcasses placed to monitor scavenger removal rates.

Carcass Size Class	Season	N	Percent remaining at 28 days	Mean length of stay (days)		95% Confidence Intervals	
				mean	se	lower limit	upper limit
				1999			
Small	Spring	9	11	9.92	3.24	3.9	15.94
	Summer	10	30	15.37	4.69	6.78	23.96
	Fall	10	20	15.79	3.1	10.11	21.47
	Winter	20	5	10.19	1.62	7.39	13
	Total	49	14	12.12	1.42	9.74	14.5
Medium	Spring	8	75	36.39	4.77	27.36	45.43
	Summer	10	70	41.49	8.9	25.17	57.81
	Fall	10	40	19.54	5.55	9.36	29.71
	Winter	16	75	40.74	5.13	31.75	49.73
	Total	44	66	35.9	3.43	30.14	41.66
Large	Spring	3	0	19.17	2.59	11.62	26.72
	Summer	10	90	54.78	6.75	42.41	67.16
	Fall	10	50	25.22	5.55	15.05	35.39
	Winter	14	64	33.52	4.91	24.82	42.22
	Total	37	62	32.25	2.91	27.33	37.16
				2000			
Small	Spring	7	14	9.54	4.01	1.75	17.33
	Summer	10	40	22.67	4.57	14.29	31.05
	Fall	10	20	15.08	3.69	8.31	21.85
	Winter	14	21	12.56	3.44	6.47	18.65
	Total	41	24	15.03	2.07	11.54	18.51
Medium	Spring	7	86	69.71	15.21	40.15	99.28
	Summer	10	90	33.58	1.41	31	36.16
	Fall	10	80	42.63	5.73	32.13	53.13
	Winter	16	44	22.23	4.25	14.78	29.69
	Total	43	70	38.81	3.53	32.88	44.74
Large	Spring	6	50	24.82	7.28	10.14	39.49
	Summer	10	80	52.83	9.7	35.05	70.61
	Fall	10	70	39.46	7.73	25.29	53.63
	Winter	20	30	15.86	3.32	10.12	21.6
	Total	46	52	26.52	3.01	21.46	31.58
Bats	Summer	10	30	20.48	4.47	12.29	28.67

Table 2. (continued).

Carcass Size Class	Season	N	Percent remaining at 28 days	Mean length of stay (days)			
					95% Confidence Intervals		
				mean	se	lower limit	upper limit
				1999-2000			
Small	Spring	16	13	9.75	2.53	5.32	14.18
	Summer	20	35	19.14	3.42	13.23	25.05
	Fall	20	20	15.44	2.41	11.27	19.62
	Winter	34	12	10.99	1.64	8.22	13.77
	Total	90	19	13.37	1.21	11.36	15.37
Medium	Spring	15	80	47.07	6.04	36.44	57.7
	Summer	20	80	50.83	6.14	40.21	61.46
	Fall	20	60	31.61	4.88	23.16	40.05
	Winter	32	59	30.79	3.53	24.81	36.78
	Total	87	68	37.33	2.46	33.23	41.42
Large	Spring	9	33	20.99	3.94	13.66	28.32
	Summer	20	85	57.68	6.55	46.36	69
	Fall	20	60	31.23	4.63	23.22	39.25
	Winter	34	44	22.63	3.03	17.5	27.77
	Total	83	57	29.45	2.19	25.81	33.09
Bats	Summer	10	30	20.48	4.47	12.29	28.67

Table 3. Estimates of the number of wind plant-related avian fatalities for the FCR I wind plant, November 1998 - June 2002.

Turbine Fatalities					
Carcass Size	Number Found	Estimated Total Annual Mortality	90% CI	Estimated #/turbine/year	90% CI
1999					
Small birds	35	137	63 - 211	1.98	0.91 - 3.05
Medium birds	2	2	2 - 3	0.03	0.03 - 0.04
Large birds	2	2	2 - 3	0.03	0.03 - 0.04
TOTAL	39	141	63 - 211	2.04	0.95 - 3.04
Raptors	3	3	3 - 4	0.05	0.04 - 0.06
2000					
Small birds	31	98	33 - 163	1.42	0.48 - 2.36
Medium birds	2	2	2 - 3	0.03	0.03 - 0.04
Large birds	0	0	0	0	0
TOTAL	33	100	35 - 165	1.45	0.51 - 2.39
Raptors	2	2	2 - 3	0.03	0.03 - 0.04
2001-2002					
Small birds	11	78	11 - 145	1.13	0.16 - 2.11
Medium birds	0	0	na	0	0
Large birds	1	2	1 - 3	0.03	0.02 - 0.05
TOTAL	12	80	13 - 147	1.16	0.19 - 2.14
Raptors	0	0	0	0	0
Total Fatalities Observed and Annual Average					
Small birds	77	101	62 - 140	1.46	0.88 - 2.04
Medium birds	4	1	1 - 2	0.02	0.01 - 0.03
Large birds	3	1	1 - 2	0.02	0.01 - 0.03
TOTAL	84	103	67 - 140	1.5	0.93 - 2.08
Raptors	5	2	1 - 3	0.03	0.02 - 0.04

Table 3. (continued).

Carcass Size	Number Found	Estimated Total Annual Mortality	90% CI	Estimated #/turbine/year	90% CI
Meteorological Tower Fatalities					
1999					
Small birds	16	62.5	29 - 96	12.5	5.80 - 19.19
Medium birds	0	0	0 - 0	0	0.00 - 0.00
Large birds	0	0	0 - 0	0	0.00 - 0.00
TOTAL	16	62.5	29 - 96	12.5	5.80 - 19.19
2000					
Small birds	4	12.7	4 - 25	2.53	0.13 - 4.93
Medium birds	0	0	0 - 0	0	0.00 - 0.00
Large birds	0	0	0 - 0	0	0.00 - 0.00
TOTAL	4	12.7	4 - 25	2.53	0.13 - 4.93
2001-2002					
Small birds	13	46	17 - 75	9.23	3.44 - 15.01
Medium birds	0	0	0 - 0	0	0 - 0
Large birds	0	0	0 - 0	0	0 - 0
TOTAL	13	46	17 - 75	9.23	3.44 - 15.01
Total Fatalities Observed and Annual Average					
Small birds	33	40	29 - 52	8.09	5.03 - 11.14
Medium birds	0	0	0 - 0	0	0 - 0
Large birds	0	0	0 - 0	0	0 - 0
TOTAL	33	40	29 - 52	8.09	5.03 - 11.14

Table 4. Estimates of the number of wind plant-related bat fatalities for the FCR I wind plant, November 1998 - June 2002.

Turbine Fatalities

Carcass Size	Number Found	Estimated Total Annual Mortality	90% CI	Estimated #/turbine/year	90% CI
		1999			
Small	47	165	47 - 326	2.38	0.68 - 4.71
		2000			
Small	18	40	18 - 78	0.63	0.26 - 1.13
		2001-2002			
Small	14	65	14 - 141	0.94	0.20 - 2.04
		Total Fatalities Observed and Annual Average			
Small	79	90	30 - 150	1.34	0.20 - 2.43

Meteorological Tower Fatalities

Carcass Size	Number Found	Estimated Total Annual Mortality	90% CI	Estimated #/turbine/year	90% CI
		No bat carcasses were located at met towers			

Table 5. Comparisons of selection ratios and risk indices for end row and mid row turbines and turbines and met towers.

	Turbines		Fatalities		Risk Indices	
Structure	Number	Percent	Number	Percent	R	B
End Row Turbine	11	15.9	8	9.9	0.6	0.37
Mid Row Turbine	58	84.1	73	90.1	1.1	0.63
Total	69	100	81	100		1.00
All Turbines	69	93.2	81	71.1	0.8	0.15
Met-towers	5	6.8	33	28.9	4.3	0.85
Total	74	100	114	100		1.00

R = %fatalities / %turbines
$B=R_i /(R_1 + R_2)$

Table 6. Comparisons of selection ratios and risk indices for turbines with and without fatalities.

	Turbines		Risk Indices	
	with fatalities	without fatalities	R	B
Turbines Closest East Rim	14	14	0.5	0.2
Turbines Closest West Rim	32	9	1.8	0.8
Total	46	23	2.3	

R = %fatalities / %turbines
$B=R_i /(R_1 + R_2)$

Figure 1. Map of Foote Creek Rim wind plant and surrounding area.

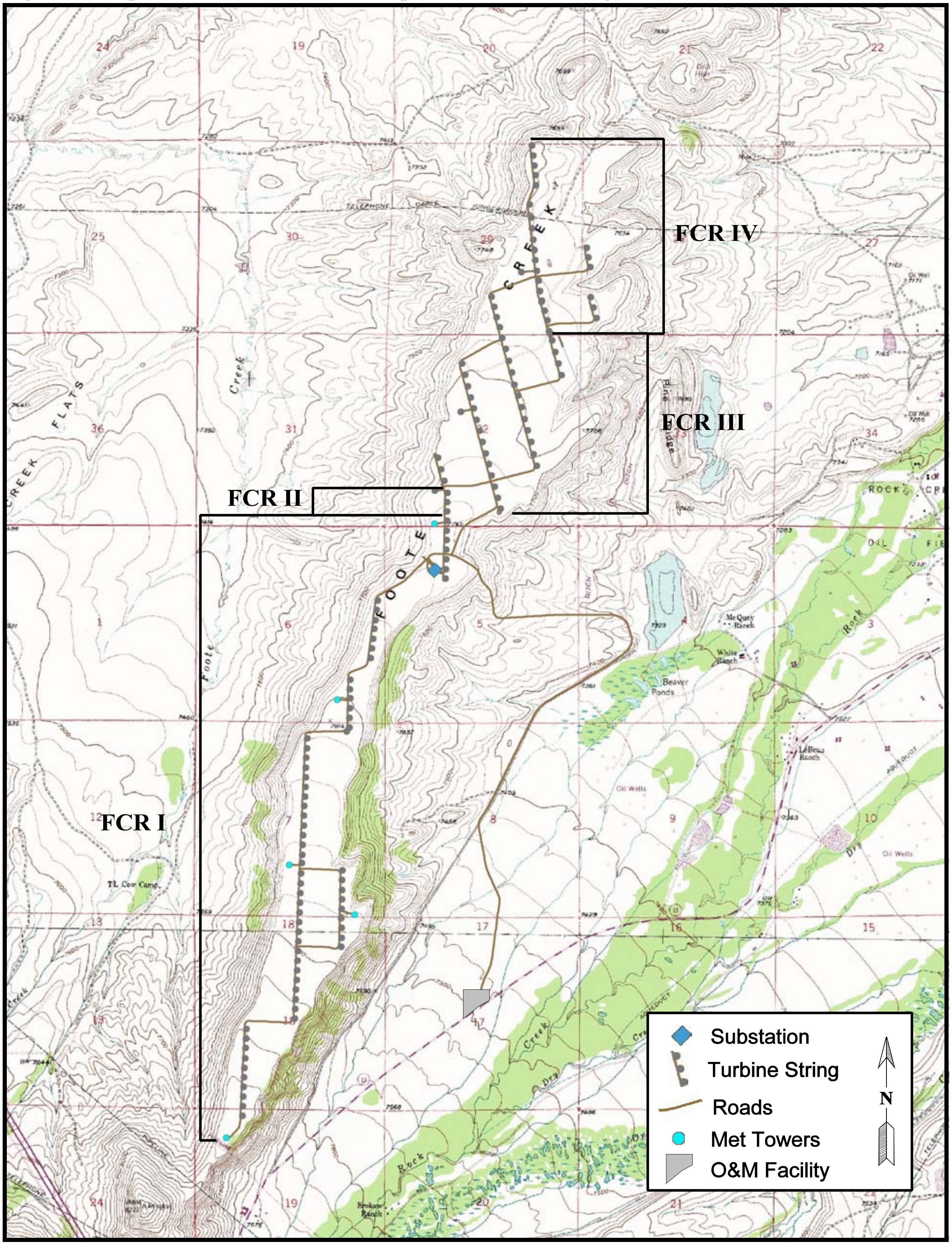


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

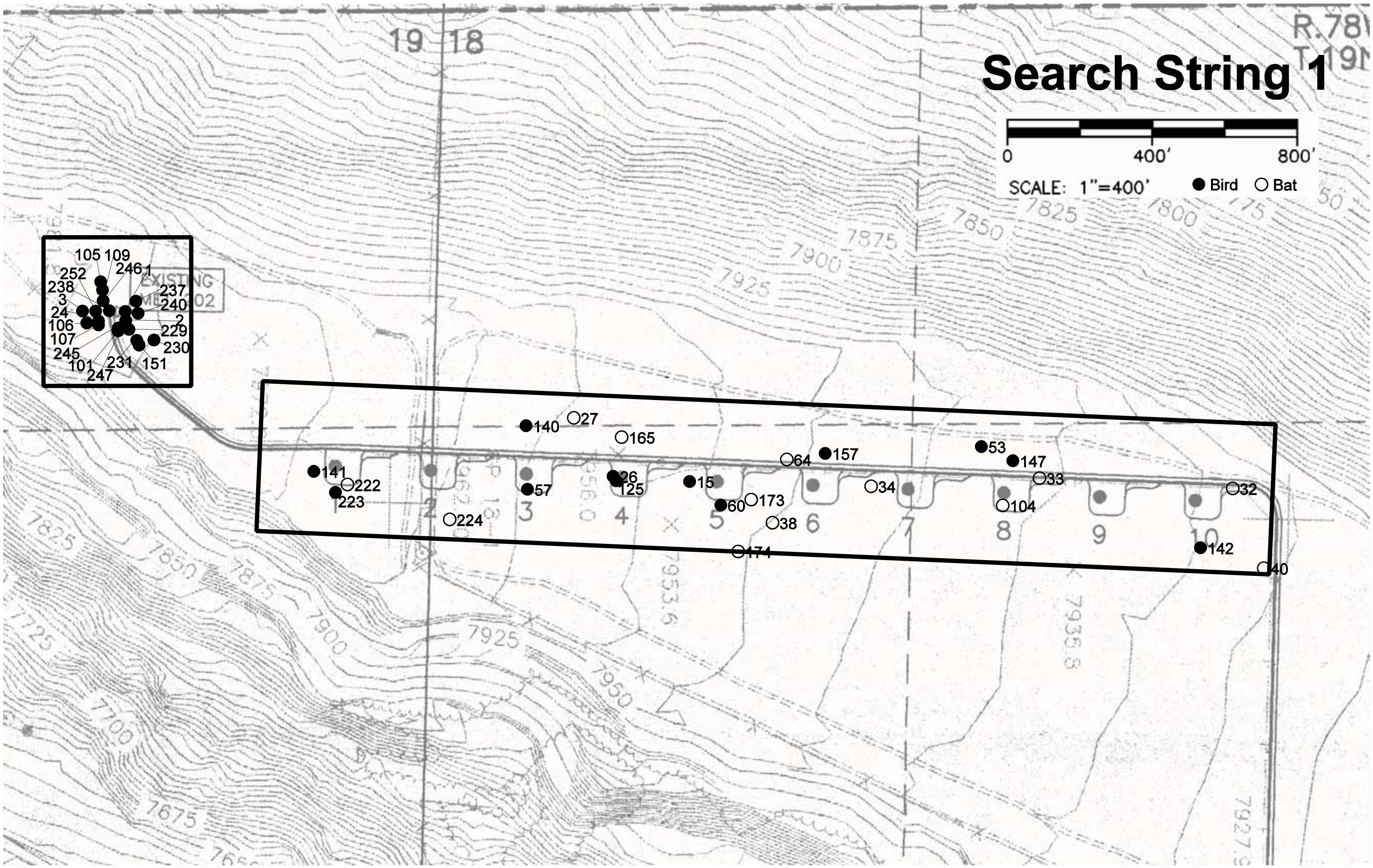


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

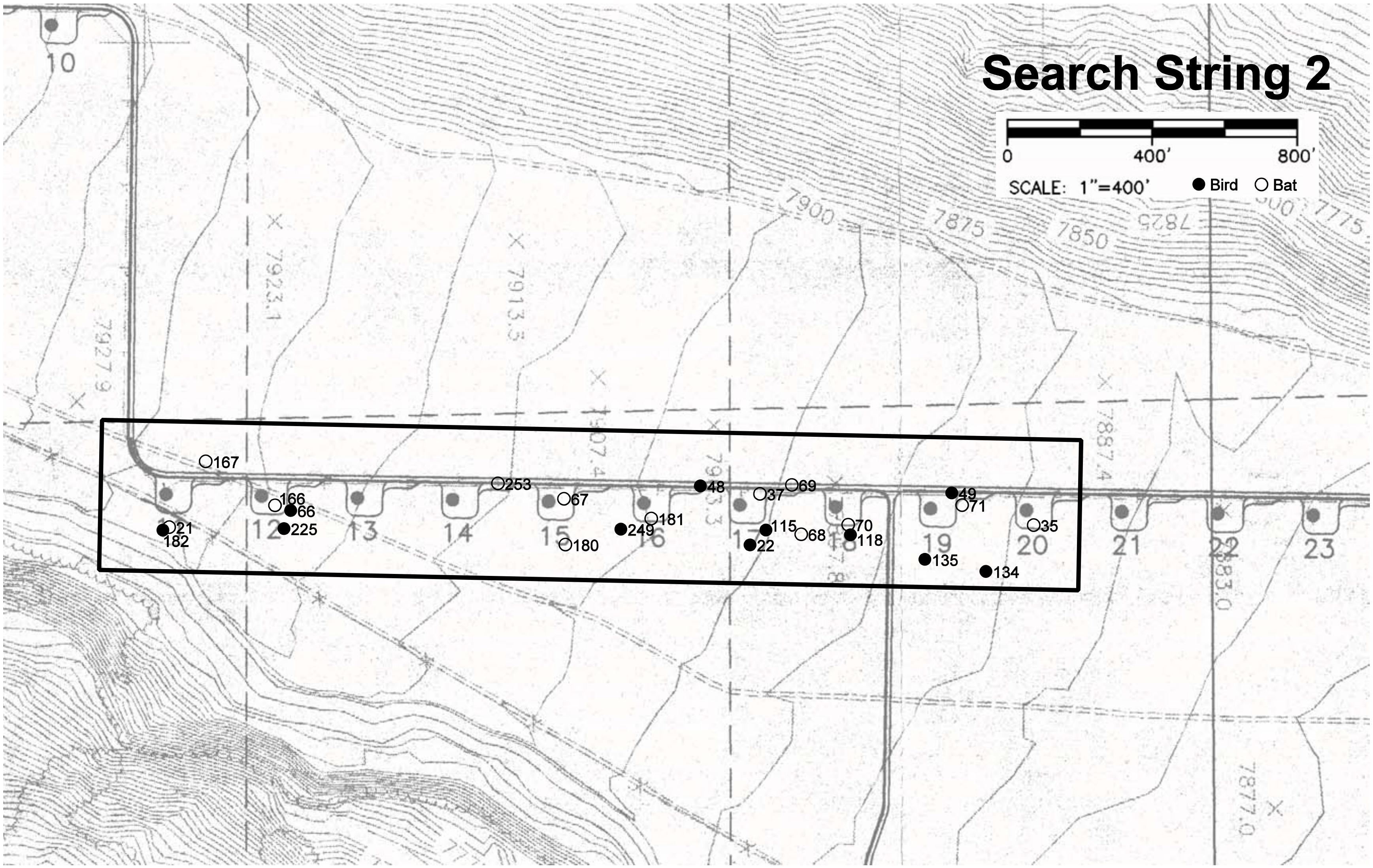


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

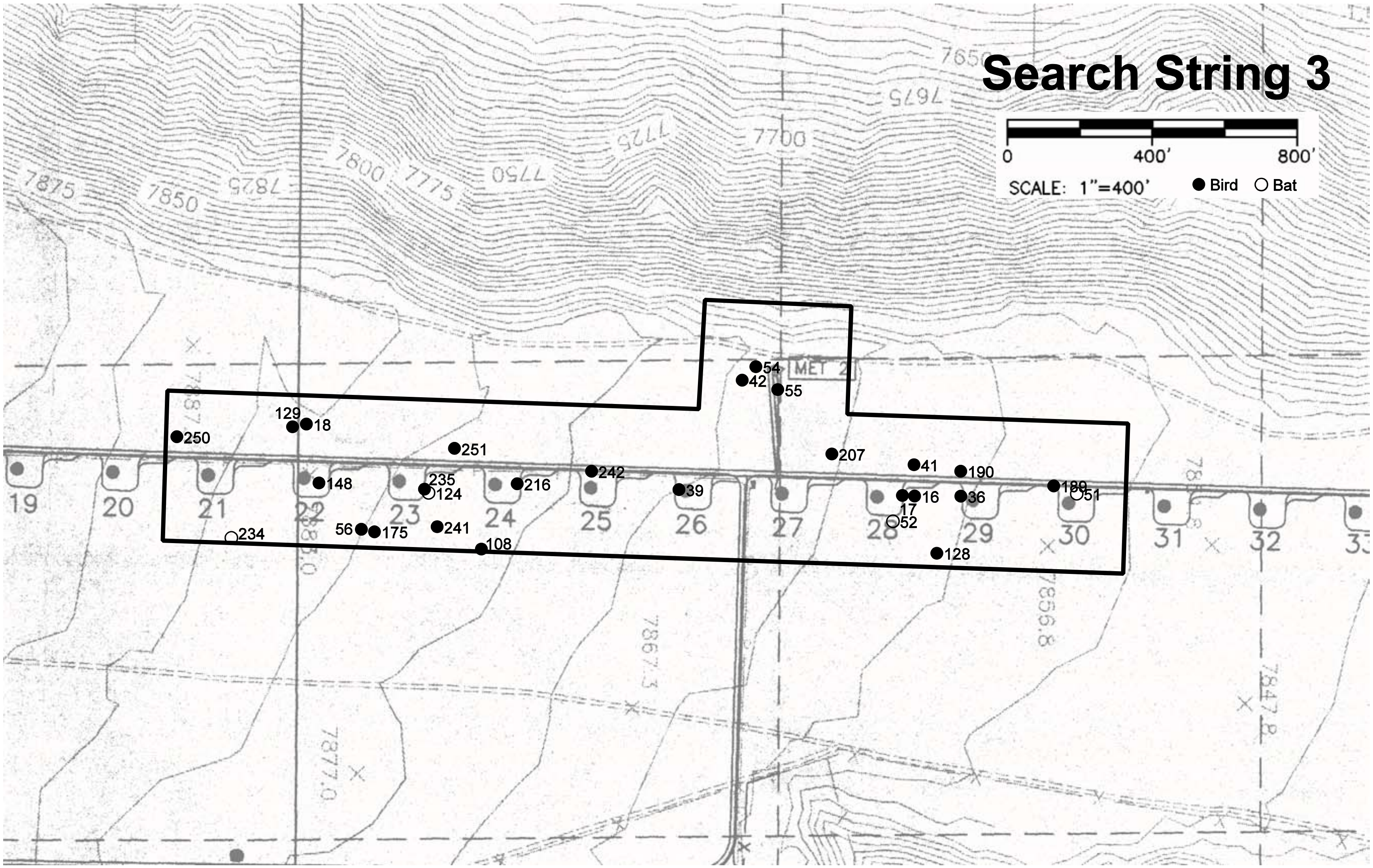


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

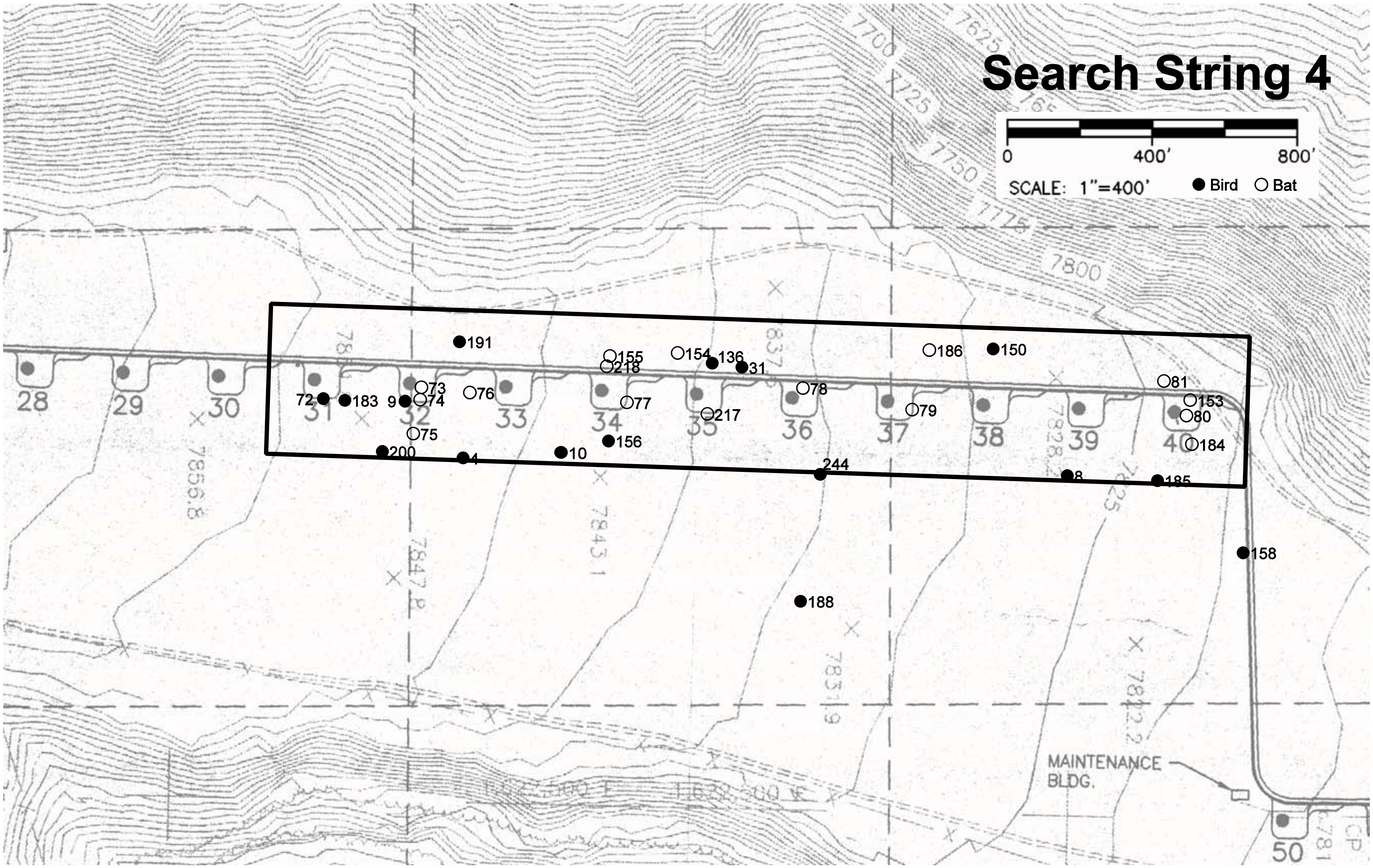


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

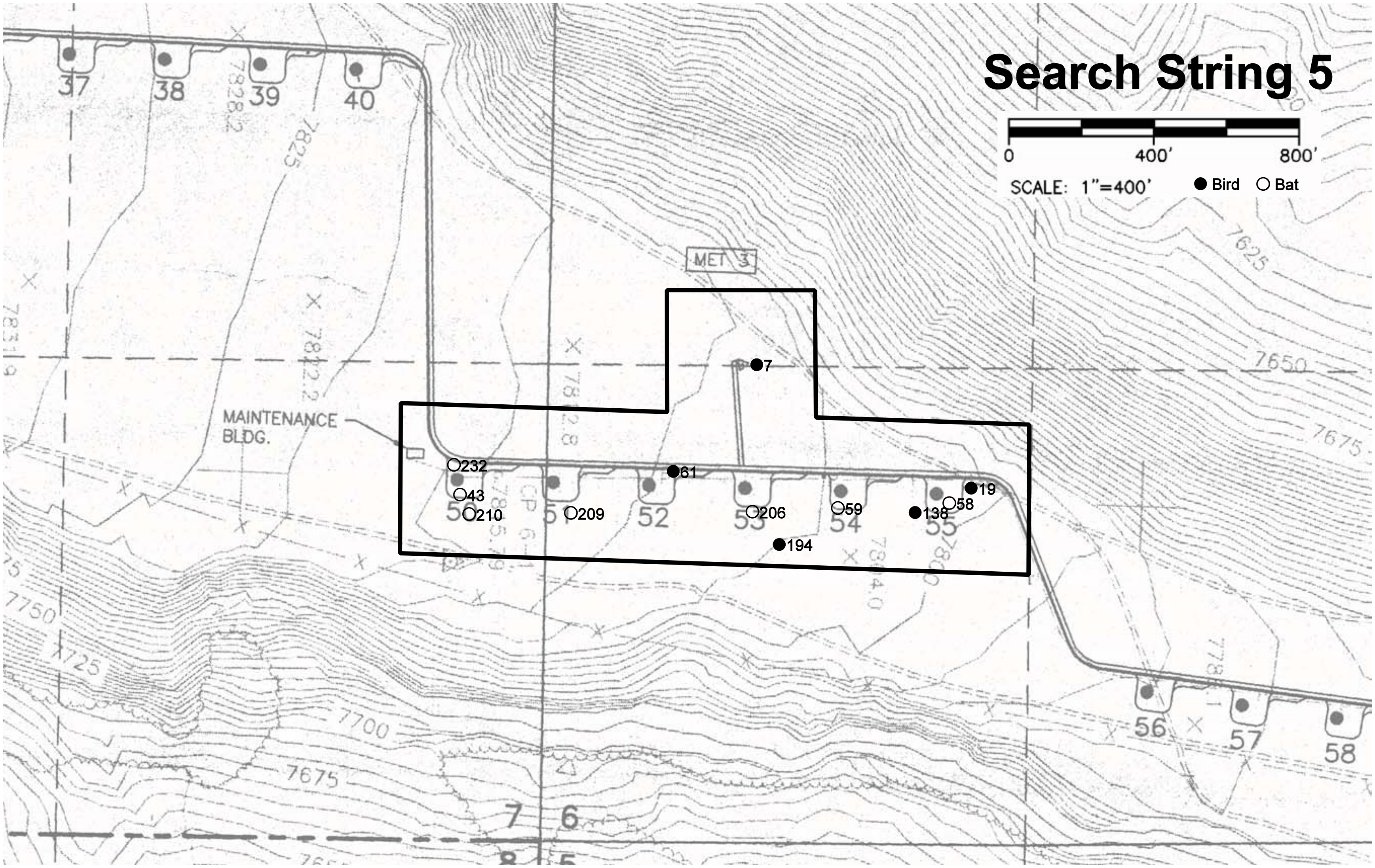


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

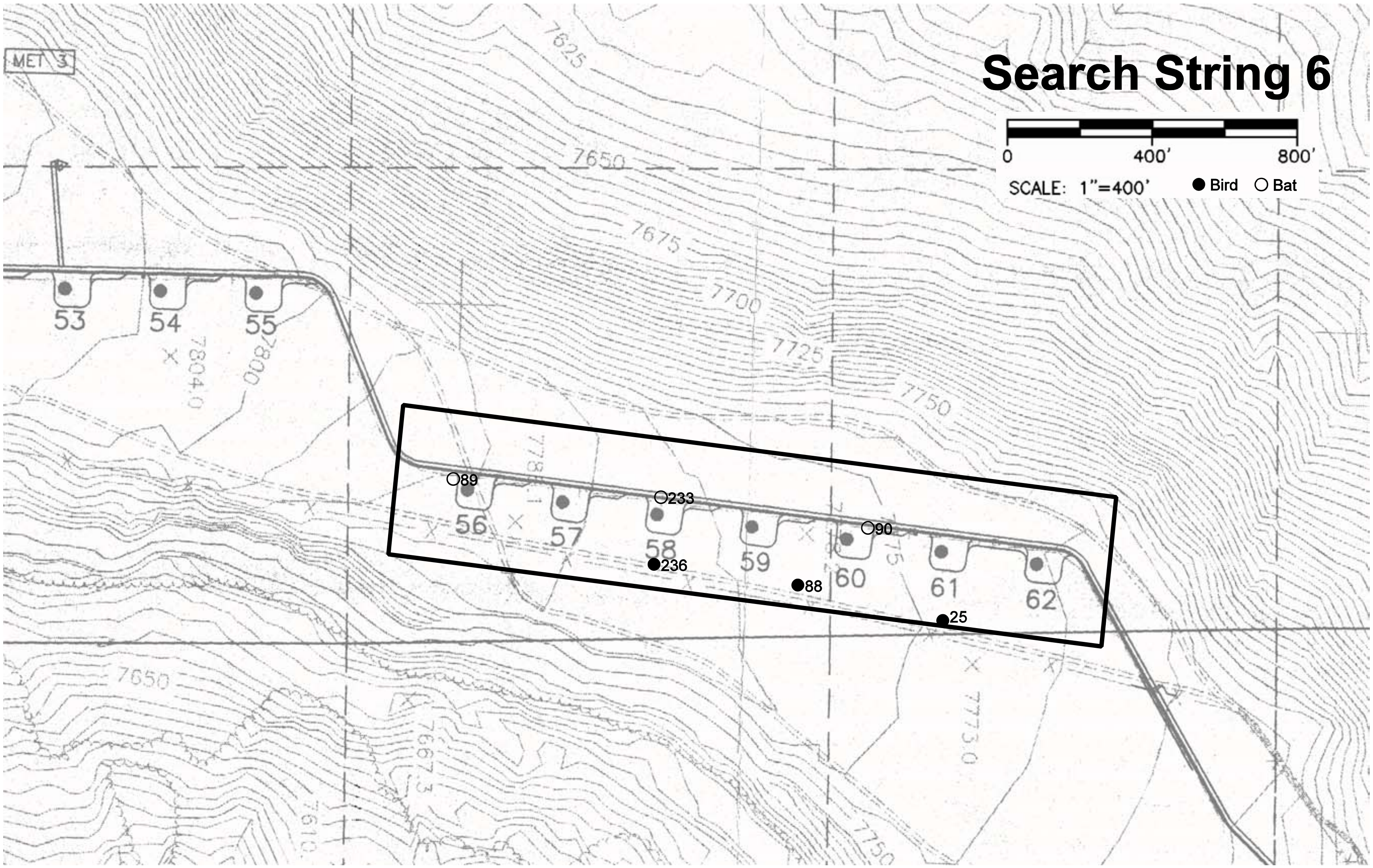


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

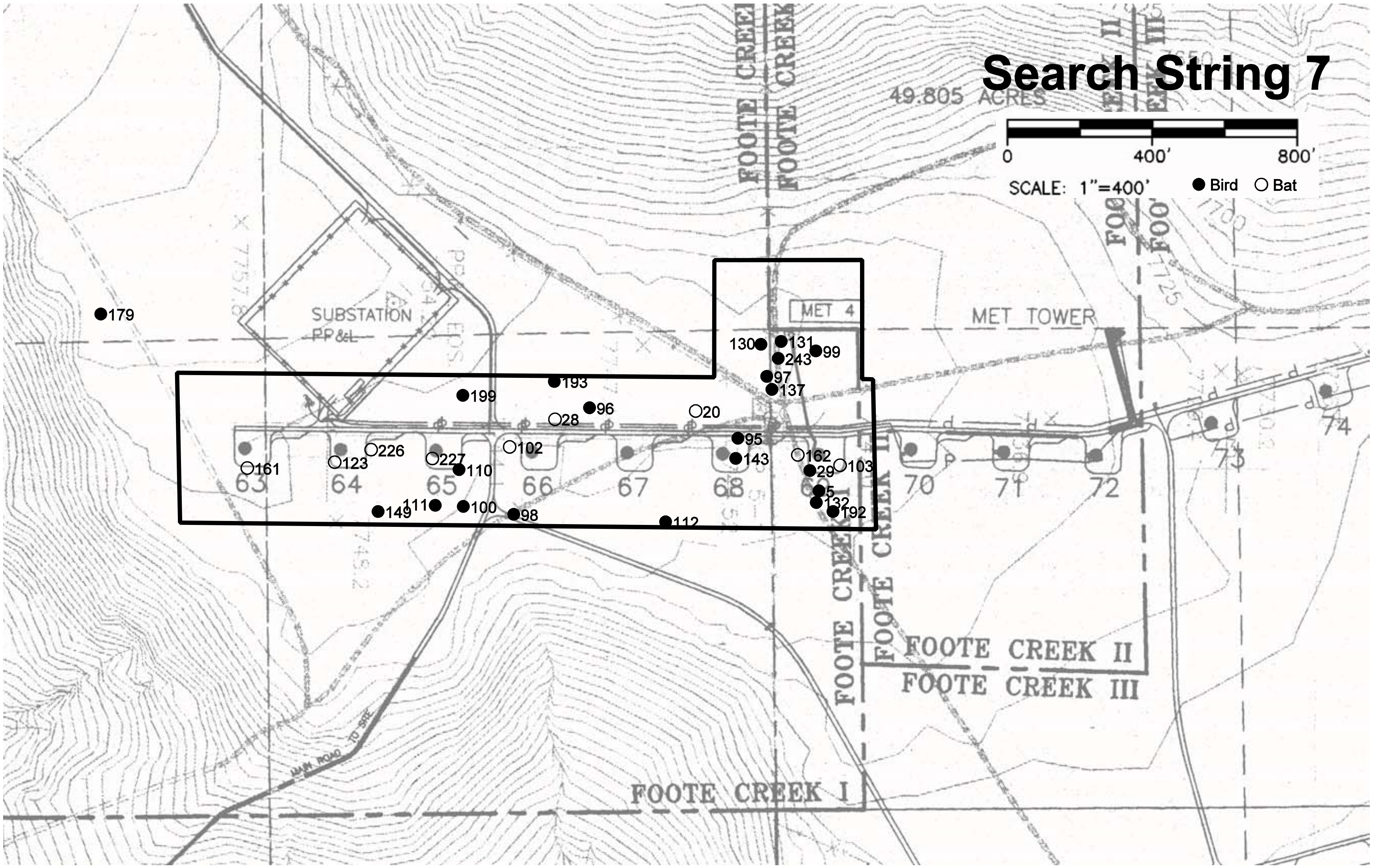


Figure 2. Carcass search strings and locations of casualties found (casualty numbers correspond to log numbers, Appendices A and B).

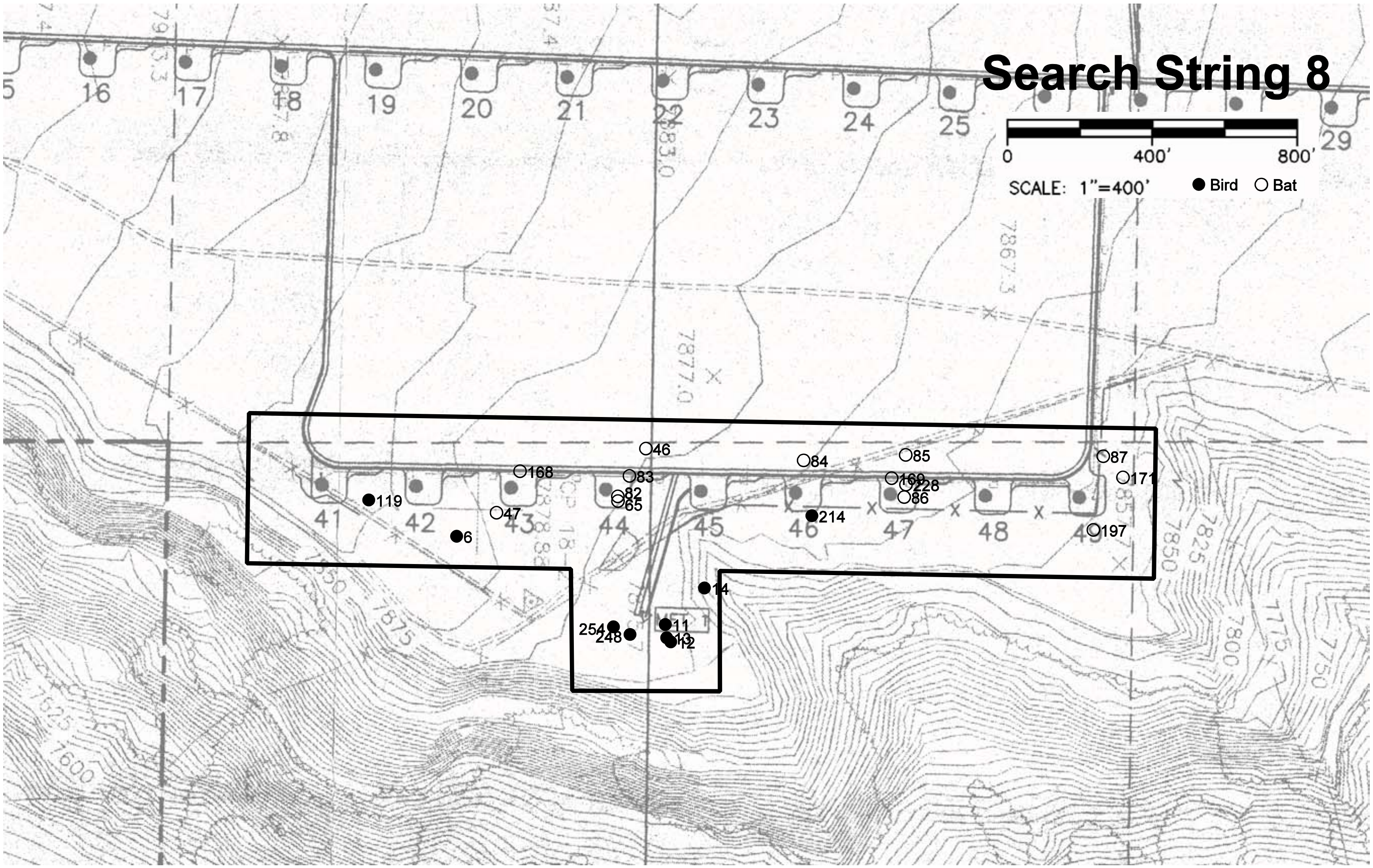
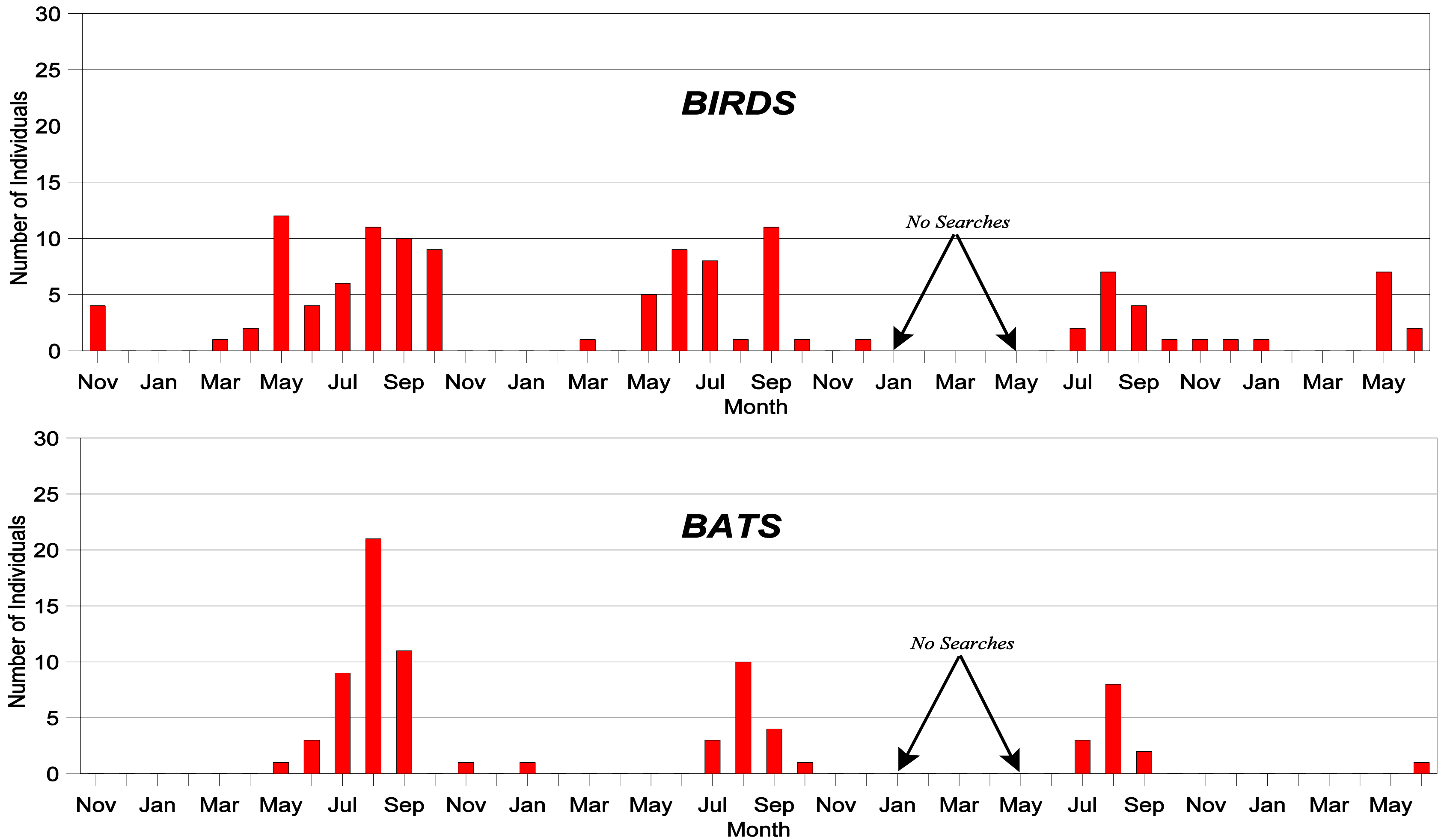


Figure 3. Number of bird and bat casualties found by month, November 1, 1998 to June 5, 2002 [Note: no carcasses searches were conducted from January 1 to May 31, 2001].



APPENDIX A

AVIAN MORTALITIES

Appendix A. Avian mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
1	American Pipit	9/30/98	No	M 202	3	Intact carcass with head wound
2	Mourning Dove	9/30/98	No	M 202	10	Feather spot
3	White-crowned Sparrow	10/14/98	No	M 202	28	Scavenged carcass with fractured neck
4	Horned Lark	11/17/98	Yes	T 33	70	Scavenged carcass (skeleton with feathers)
5	Sage Thrasher	3/31/99	Yes	T 69	30	Scavenged carcass with fractured neck
6	Northern Harrier	4/19/99	Yes	T 42	54	Intact carcass with abrasions on head and fractured wing and leg
7	Dark-eyed Junco	4/26/99	Yes	M 3	13.5	Intact carcass with no obvious signs of trauma
8	American Kestrel	5/12/99	Yes	T 39	60	Dismembered carcass consisting of 3 pieces
9	Unidentified Passerine	5/12/99	Yes	T 32	16	Scavenged carcass consisting of 1 leg
10	Vesper Sparrow	5/12/99	Yes	T 34	65	Intact carcass with head and chest wounds
11	Hermit Thrush	5/13/99	Yes	M 1	20	Intact carcass with fractured wing
12	Brewer’s Sparrow	5/13/99	Yes	M 1	31	Intact carcass with abrasions on shoulder
13	Vesper Sparrow	5/13/99	Yes	M 1	29	Intact carcass with head and neck trauma
14	Chipping Sparrow	5/13/99	Yes	M 1	50	Scavenged decapitated carcass
15	Lark Bunting	5/24/99	Yes	T 5	21.5	Scavenged carcass with head trauma and fractured wing and leg
16	Chipping Sparrow	5/25/99	Yes	T 28	32	Intact carcass with trauma to breast and left side
17	Brewer’s Sparrow	5/25/99	Yes	T 28	24	Intact carcass with trauma to left side and fractured wing
18	Horned Lark	5/25/99	Yes	T 22	60	Scavenged carcass consisting of leg, foot and pelvis
19	Horned Lark	5/25/99	Yes	T 55	30	Intact carcass with apparent internal injuries
22	Western Meadowlark	6/7/99	Yes	T 17	39	Dismembered carcass consisting of body and wing
24	Warbling Vireo	6/7/99	No	M 202	25	Intact carcass with fractured neck
25	Unidentified Blackbird	6/10/99	Yes	T 61	59	Scavenged carcass; portion of one wing
26	Horned Lark	6/21/99	Yes	T 4	6	Scavenged carcass with trauma to head
29	Horned Lark	7/5/99	Yes	T 69	15	Scavenged carcass consisting of two wings and bones
31	Horned Lark	7/9/99	Yes	T 35	42	Intact carcass in road; had been run over by vehicle
36	Horned Lark	7/19/99	Yes	T 29	10	Intact carcass in road; had been run over by vehicle
39	Horned Lark	7/19/99	Yes	T 26	4	Intact decapitated carcass with fractured neck and wings

Appendix A. Avian mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
41	Horned Lark	7/19/99	Yes	T 28	41	Scavenged flightless juvenile, death likely due to predation
42	American Robin	7/19/99	Yes	M 2	32	Scavenged carcass with fractured neck and wing
48	Brewer's Sparrow	8/2/99	Yes	T 17	26	Intact carcass with fractured leg and neck
49	Horned Lark	8/2/99	Yes	T 19	19	Intact carcass with fractured leg and neck
53	Unidentified Swallow	8/16/99	Yes	T 8	42	Scavenged carcass consisting of wing and part of body
54	Horned Lark	8/16/99	Yes	M 2	21	Scavenged carcass with fractured wing, legs, neck and ribs
55	Western Tanager	8/16/99	Yes	M 2	18	Intact carcass with abrasions and fractured wing
56	Unidentified Passerine	8/16/99	Yes	T 23	45	Feather spot
57	Horned Lark	8/16/99	Yes	T 3	12	Scavenged carcass with fractured ribs and wing
60	Cliff Swallow	8/17/99	Yes	T 5	20	Scavenged carcass with abrasions and fractured ribs
61	Horned Lark	8/17/99	Yes	T 52	21	Scavenged carcass on road; had been run over by vehicle
66	Wilson's Warbler	8/31/99	Yes	T 12	27	Scavenged carcass with abrasions and fractured foot
72	Unidentified Passerine	8/31/99	Yes	T 31	18	Feather spot
88	MacGillivray's Warbler	9/2/99	Yes	T 60	57	Scavenged carcass with fractured wings and legs
95	Rock Wren	9/9/99	No	T 68	19	Intact carcass with abrasions on torso and fractured leg
96	Townsend's Warbler	9/13/99	Yes	T 67	49	Intact carcass with no obvious signs of trauma
97	Vesper Sparrow	9/13/99	Yes	M 4	40	Intact carcass with no obvious signs of trauma
98	Wilson's Warbler	9/13/99	Yes	T 66	55	Intact carcass with abrasions on back and head and fractured wing
99	Vesper Sparrow	9/13/99	Yes	M 4	26	Intact carcass with fractured wing
100	House Wren	9/13/99	Yes	T 65	54.5	Intact carcass with no obvious signs of trauma
101	House Wren	9/13/99	No	M 202	21	Intact carcass with abraded head
105	Chipping Sparrow	9/13/99	Yes	M 202	29.5	Intact carcass with fractured wing and leg
106	Chipping Sparrow	9/13/99	Yes	M 202	27	Intact carcass with head trauma
107	Common Poorwill	10/11/99	Yes	M 202	19	Dismembered carcass consisting of head, body and wing
108	Rock Wren	10/11/99	Yes	T 24	61	Intact carcass with fractured wing
109	Horned Lark	10/11/99	Yes	M 202	20	Injured bird (fractured wing); not collected
110	American Kestrel	10/12/99	Yes	T 65	22	Scavenged carcass too desiccated for meaningful necropsy

Appendix A. Avian mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
111	Rock Wren	10/12/99	Yes	T 65	47	Intact carcass with fractured wing, ribs, and leg
112	Unidentified Passerine	10/12/99	Yes	T 68	77	Feather spot
115	Brown Creeper	10/21/99	No	T 17	31.5	Intact carcass with no obvious sings of trauma
118	Brown Creeper	10/25/99	Yes	T 18	28	Intact carcass with bruising on breast
119	Western Grebe	10/26/99	Yes	T 41	44	Dismembered carcass, left side abrasions, left wing missing, fractured leg
125	Horned Lark	3/27/00	Yes	T 4	5	Intact carcass, probably hit turbine base when blades were down
128	Horned Lark	5/22/00	Yes	T 29	54	Scavenged carcass; appears to have been scavenged by a rodent
129	Green-tailed towhee	5/22/00	Yes	T 22	44	Intact carcass; blades on ground at time of death; may have hit base.
130	Horned Lark	5/23/00	Yes	M 4	25	Dismembered carcass; wing only; found under guy wires
131	Brewer's Sparrow	5/23/00	Yes	M 4	9	Intact carcass
132	Vesper Sparrow	5/23/00	Yes	T 69	39	Intact carcass
134	Green-tailed towhee	6/5/00	Yes	T 20	61	Dismembered carcass; fresh wing and contour feathers in rodent burrow
135	Horned Lark	6/5/00	Yes	T 19	43	Dismembered carcass; possible ground squirrel scavenging
136	Ruby-crowned Kinglet	6/5/00	Yes	T 35	30	Intact carcass; probable migrant; ants scavenging
137	Brewer's Sparrow	6/6/00	No	M 4	48	Intact carcass; may have hit guy wire; trauma to breast and neck
138	Horned Lark	6/6/00	No	T 55	30	Intact carcass; carcass fresh and in good condition
140	Horned Lark	6/19/00	Yes	T 3	40	Scavenged carcass; head missing from body
141	Horned Lark	6/19/00	Yes	T 1	15	Scavenged carcass; both wings, legs and feet present
142	Horned Lark	6/19/00	Yes	T 10	41	Scavenged carcass; sternum, primaries, secondaries, and tail feathers
143	Horned Lark	6/20/00	Yes	T 68	10	Scavenged carcass; immediately adjacent to blades on ground
147	Tree Swallow	7/3/00	Yes	T 8	29	intact carcass; wound on breast/belly
148	Mountain Bluebird	7/5/00	Yes	T 22	13	Intact carcass; insect infestation; no visible injury
149	Horned Lark	7/5/00	Yes	T 64	65	Feather spot; wing and breast feathers
150	Mountain Bluebird	7/6/00	No	T 38	48	Scavenged carcass; large hole in torso; unknown scavenger
151	Vesper Sparrow	7/10/00	No	M 202	32	Scavenged carcass; rectrices missing body; possible rodent scavenger
156	American Kestrel	7/19/00	Yes	T 34	43	Dismembered carcass; two wings found scavenged
157	Vesper Sparrow	7/31/00	Yes	T 6	31	Dismembered carcass; body and head missing

Appendix A. Avian mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
158	Common Nighthawk	7/27/00	No	unk	-	Intact carcass; 1m south of road; compressed by truck tire, 140m from T 40
175	Rock Wren	8/29/00	Yes	T 23	47	Intact carcass; left eye scavenged; broken left wing, broken ribs
179	Horned Lark	9/5/00	No	unk	-	Feather spot; possible mammal scavenging; 168 m from T 68
182	Townsend's Warbler	9/11/00	Yes	T 11	28	Dismembered carcass; torso, head, wings missing
183	Wilson's Warbler	9/12/00	Yes	T 31	30	Dismembered carcass; part of head, most of tail, 1 wing and body feathers
185	Townsend's Warbler	9/12/00	Yes	T 40	61	Dismembered carcass; head and torso missing
188	White-crowned Sparrow	9/26/00	No	unk	-	Intact carcass; fresh carcass, no visible injuries; 184 m from T 36
189	Horned Lark	9/27/00	Yes	T 30	19	Scavenged carcass; smashed on road
190	Chipping Sparrow	9/27/00	Yes	T 29	25	Intact carcass, desiccated carcass
191	Horned Lark	9/27/00	No	T 32	53	Intact carcass, broken wings
192	Yellow-rumped Warbler	9/27/00	Yes	T 69	42	Intact carcass
193	Horned Lark	9/27/00	Yes	T 66	61	Intact carcass
194	Short-eared Owl	9/28/00	Yes	T 53	56	Scavenged carcass; dehydrated and scavenged
199	Unidentified Passerine	10/24/00	Yes	T 65	55	Dismembered carcass; small piece of carcass including leg
200	Unidentified Blackbird	12/5/00	Yes	T 32	64	Feather spot revealed under melting snow; likely died before late Oct storm
242	Horned Lark	7/16/01	No	T 25	NR	Dismembered flightless juvenile most likely road or predator kill; found by Jeff Gruver (UW) during bat studies on FCR
207	Horned Lark	7/30/01	Yes	T 28	50	Dismembered carcass; head and feather spot found
214	House Wren	8/6/01	No	T 46	22	Intact carcass with broken wing and skull; found by Jeff Gruver (UW) during bat studies on FCR
216	Horned Lark	8/13/01	No	T 24	17	Feather spot found by Jeff Gruver (UW) during bat studies on FCR
223	Horned Lark	8/28/01	Yes	T 1	28	Insect infested; carcass dessicated
225	Unidentified Warbler	8/20/01	No	T 12	33	Insect infested, dessicated and probable small mammal scavenging
229	Wilson's Warbler	8/29/01	Yes	M 202	20	Intact decomposed carcass
230	Brewer's Sparrow	8/29/01	Yes	M 202	37	Observed hitting guy wire and falling to ground; gusty winds 20 - 40 mph
231	Unidentified Thrush	8/29/01	Yes	M 202	27	Two feather spots within 2 meters of each other
235	Chipping Sparrow	9/13/01	Yes	T 23	23	Insect infested

Appendix A. Avian mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
236	Unidentified Warbler	9/13/01	Yes	T 58	42	Dismembered; left wing separated from body at same location
237	American Robin	9/28/01	Yes	M 202	15	Feather spot and left wing found
238	Lincoln Sparrow	9/28/01	Yes	M 202	8	Intact; very fresh
240	American Robin	10/23/01	Yes	M 202	16	Dismembered, right wing and back found
241	Unidentified Passerine	11/6/01	Yes	T 23	50	Feather spot
243	Unidentified Passerine	12/21/01	Yes	M4	22	Feather spot
244	Lesser Scaup	1/7/02	Yes	T36	70	Dismembered, right wing, left wing, and back found
245	Green-tailed Towhee	5/14/02	Yes	M202	12	Intact carcass, male in breeding plumage
246	Vesper Sparrow	5/14/02	Yes	M202	13	Intact carcass
247	Savannah Sparrow	5/14/02	Yes	M202	15	Intact carcass
248	Unidentified Blackbird	5/14/02	Yes	M1	19	Wing and feathers found
249	Unidentified Passerine	5/14/02	Yes	T16	30	Feather spot
250	Black-throated Blue Warbler	5/21/02	Yes	T21	41	Intact carcass, male in breeding plumage
251	House Wren	5/27/02	Yes	T23	51	Intact carcass
252	Lincoln Sparrow	6/3/02	Yes	M202	20	Intact carcass
254	Cliff Swallow	6/5/02	Yes	M1	29	Intact carcass

[a] matches log no. on Figure 1
[b] T = turbine; M = meteorological tower (met tower)
NR=not recorded

APPENDIX B

BAT MORTALITIES

Appendix B. Bat mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
20	Little Brown Bat	5/27/99	Yes	T 68	40	Intact carcass with fractured leg and contusions on right side
21	Hoary Bat	6/7/99	Yes	T 11	25	Intact carcass with head trauma and fractured wing
27	Little Brown Bat	6/21/99	Yes	T 3	67	Intact carcass with fractured wing
28	Hoary Bat	6/25/99	Yes	T 66	35	Scavenged carcass with fractured wings
32	Hoary Bat	7/14/99	No	T 10	33	Intact carcass with fractured wing
33	Hoary Bat	7/19/99	Yes	T 8	35	Intact carcass with fractured wings
34	Silver-haired Bat	7/19/99	Yes	T 7	34	Intact, desiccated carcass with fractured wing
35	Hoary Bat	7/19/99	Yes	T 20	12	Intact carcass with fractured wings
37	Hoary Bat	7/19/99	Yes	T 17	19	Intact carcass with fractured wing
38	Hoary Bat	7/19/99	Yes	T 5	65	Intact carcass with abrasions on side
40	Hoary Bat	7/19/99	Yes	T 10	86	Scavenged carcass with fractured wing, ribs and leg
43	Hoary Bat	7/19/99	Yes	T 50	12	Intact carcass with fractured wing and leg
46	Hoary Bat	7/28/99	No	T 44	48	Intact carcass with fractured wing
47	Hoary Bat	8/2/99	Yes	T 43	23	Intact carcass with fractured neck and ribs
51	Hoary Bat	8/9/99	No	T 30	10	Intact carcass
52	Hoary Bat	8/16/99	Yes	T 28	21	Scavenged carcass with abrasions on back
58	Hoary Bat	8/17/99	Yes	T 55	13	Intact carcass with fractured ribs and wing
59	Hoary Bat	8/17/99	Yes	T 54	11.5	Intact carcass with abrasions and fractured ribs
64	Hoary Bat	8/30/99	No	T 6	31	Intact carcass with fractured neck and wing
65	Hoary Bat	8/30/99	No	T 44	13	Intact carcass too desiccated for meaningful necropsy
67	Hoary Bat	8/31/99	Yes	T 15	11.5	Intact carcass too desiccated for meaningful necropsy
68	Hoary Bat	8/31/99	Yes	T 18	39	Intact carcass with fractured wing and legs
69	Hoary Bat	8/31/99	Yes	T 18	38	Intact carcass with fractured wing
70	Hoary Bat	8/31/99	Yes	T 18	18.5	Intact carcass with abraded head
71	Hoary Bat	8/31/99	Yes	T 19	13	Dismembered carcass with abraded back and fractured wing

Appendix B. Bat mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
73	Hoary Bat	8/31/99	Yes	T 32	8	Intact carcass too desiccated for meaningful necropsy
74	Hoary Bat	8/31/99	Yes	T 32	15	Intact carcass with abrasions on back
75	Hoary Bat	8/31/99	Yes	T 32	42	Intact carcass with fractured wing
76	Little Brown Bat	8/31/99	Yes	T 33	33	Intact carcass with abrasions on wing
77	Big Brown Bat	8/31/99	Yes	T 34	22	Intact carcass with fractured wing
78	Hoary Bat	8/31/99	Yes	T 36	11.5	Intact carcass with fractured wing
79	Hoary Bat	8/31/99	Yes	T 37	21.5	Intact carcass with fractured skull
80	Hoary Bat	8/31/99	Yes	T 40	9.5	Intact carcass too desiccated for meaningful necropsy
81	Hoary Bat	8/31/99	Yes	T 40	27	Intact carcass with fractured wing
82	Hoary Bat	9/1/99	Yes	T 44	10.5	Intact carcass with fractured wing
83	Hoary Bat	9/1/99	Yes	T 44	21.5	Intact carcass with abrasions and fractured ribs, wing and leg
84	Hoary Bat	9/1/99	Yes	T 46	27	Intact carcass with fractured back and leg
85	Hoary Bat	9/1/99	Yes	T 47	35	Intact carcass with abrasions and fractured wing
86	Hoary Bat	9/1/99	Yes	T 47	10.5	Intact carcass too desiccated for meaningful necropsy
87	Little Brown Bat	9/1/99	Yes	T 49	40	Intact carcass with fractured wing and leg
89	Hoary Bat	9/2/99	Yes	T 56	15	Intact carcass with fractured wing
90	Hoary Bat	9/2/99	Yes	T 60	20	Intact carcass with fractured wing and leg
102	Hoary Bat	9/13/99	Yes	T 66	20	Intact carcass too desiccated for meaningful necropsy
103	Hoary Bat	9/13/99	Yes	T 69	21	Dismembered carcass consisting of two wings, head
104	Hoary Bat	9/14/99	Yes	T 8	11.5	Intact carcass too desiccated for meaningful necropsy
123	Unidentified Bat	11/9/99	Yes	T 64	62	Dismembered carcass, very old
124	Unidentified Bat	1/4/00	Yes	T 23	25	Dismembered carcass, very old
153	Hoary Bat	7/19/00	Yes	T 40	10	Intact carcass, broken wing, carcass decomposed
154	Hoary Bat	7/19/00	Yes	T 35	41	Scavenged carcass, possible broken wings and back
155	Hoary Bat	7/19/00	Yes	T 34	30	Intact carcass, injury to belly, right elbow pushed thru wing membrane

Appendix B. Bat mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
161	Hoary Bat	8/2/00	Yes	T 63	17	Scavenged carcass, insect scavenging, wing membrane ripped
162	Hoary Bat	8/2/00	Yes	T 69	18	Scavenged carcass, insect scavenging
165	Hoary Bat	8/3/00	No	T 4	40	Scavenged carcass, intact but hollowed out, insect scavenging
166	Hoary Bat	8/14/00	Yes	T 12	16	Intact carcass, both wings broken, injury to abdomen, carcass wet
167	Hoary Bat	8/14/00	Yes	T 12	51	intact carcass, broken right wing at shoulder
168	Hoary Bat	8/15/00	Yes	T 43	15	Dismembered carcass, mildly Insect scavenged, decapitated.
169	Hoary Bat	8/15/00	Yes	T 47	12	Scavenged carcass, insect scavenging
171	Little Brown Bat	8/15/00	Yes	T 49	39	Scavenged carcass, most all meat eaten, dry carcass, tears in wings
173	Silver-haired Bat	8/28/00	Yes	T 5	33	Intact carcass, broken left forearm, wet carcass, damaged lower abdomen
174	Hoary Bat	8/28/00	Yes	T 5	62	Scavenged carcass, rodent scavenging, insect infestation
180	Silver-haired Bat	9/11/00	Yes	T 15	36	Intact carcass, tear in right wing membrane, torn fur from body on back
181	Hoary Bat	9/11/00	Yes	T 16	13	Intact carcass, little scavenging on rump
184	Little Brown Bat	9/12/00	Yes	T 40	31	Intact carcass, wound to underside of body.
186	Hoary Bat	9/12/00	Yes	T 37	55	Scavenged, head and torso missing, found in ground squirrel burrow
197	Silver-haired Bat	10/10/00	Yes	T 49	29	Intact carcass
206	Hoary Bat	7/30/01	No	T 53	20	Insect infested
208	Hoary Bat	7/30/01	Yes	T 51	28	Insect infested
210	Hoary Bat	7/30/01	Yes	T 50	30	Insect infested, very dessicated
217	Hoary Bat	8/14/01	Yes	T 35	18	Insect infested
218	Hoary Bat	8/14/01	Yes	T 34	23	Insect infested
222	Hoary Bat	8/28/01	Yes	T 1	17	Insect infested
224	Hoary Bat	8/28/01	Yes	T 2	44	Insect infested, carcass dessicated and decomposed
226	Hoary Bat	8/29/01	Yes	T 64	25	Intact carcass but decomposed
227	Silver-haired Bat	8/29/01	Yes	T 65	8	Intact carcass, dehydrated
228	Hoary Bat	8/29/01	Yes	T 47	16	Intact carcass

Appendix B. Bat mortalities found in Foote Creek Rim Construction Unit I (FCR I), November 3, 1998 - June 5, 2002.

Log No.[a]	Species	Date	Found During Carcass Search?	Plot[b]	Distance from tower (m)	Comments
232	Hoary Bat	8/29/01	Yes	T 50	10	Intact carcass
233	Silver-haired Bat	9/3/01	No	T 58	15	Intact carcass, found by Jeff Gruver (UW) during bat studies on FCR
234	Hoary Bat	9/13/01	Yes	T 22	57	Intact carcass but decomposed
253	Little Brown Bat	6/3/02	Yes	T14	40	Intact carcass

[a] matches log no. on Figure 1

[b] T = turbine; M = meteorological tower (met tower)