FINAL REPORT

AVIAN AND BAT MORTALITY ASSOCIATED WITH THE VANSYCLE WIND PROJECT, UMATILLA COUNTY, OREGON 1999 STUDY YEAR

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EXECUTIVE SUMMARY

The Avian Monitoring Plan for the Vansycle Wind Project located in Umatilla County, Oregon outlined a detailed protocol for estimation of bird and bat fatalities associated with the project. The Technical Advisory Committee (TAC) made up of experts from the cooperating agencies and ESI Vansycle Partners, L.P., local landowners, and representatives of Umatilla County agreed to meet after completion of one year of the monitoring program to discuss results of the monitoring studies, the evaluation of methodology, and the need for further study. This report presents results of carcass searches for the 1999 study year at the Vansycle Ridge Wind Project.

The windplant is comprised of 38 660-kilowatt Vestas turbines arranged in two strings, with 28 turbines on String A and 10 on String B. Carcass searches were conducted on half the turbines once every two weeks during the study, with all turbines searched each 28-day period. To estimate windplant mortality, the total number of carcasses found was adjusted for "length of stay" (scavenging) and searcher efficiency bias. Twelve bird and ten bat fatalities were found during the study. During searcher efficiency trials, searchers detected 50.0% of the small birds and 87.5% of the large birds. Scavenger removal trials indicated that carcasses remained on the search area for an average of 25.0 days before being removed. Based on the number of fatalities found adjusted for searcher efficiency and scavenger removal rates, the total number of turbine-related casualties in 1999 for the Vansycle Ridge Wind Project was estimated to be 24 birds and 28 bats. The fatality rate per year was estimated to be 0.63 birds/turbine and 0.74 bats/turbine. Most of the windplant-related avian casualties on Vansycle Ridge were passerines, and many of these were likely nocturnal migrants. No raptor casualties were found during the study period. Mortality of large birds was apparently limited to chukars and gray partridge, two introduced upland gamebirds. Data collected indicate that avian and bat mortality appears to be relatively low on Vansycle Ridge. Overall results of the carcass search studies indicate that the monitoring protocol used for this study is sufficient to provide data required to adequately evaluate effects of windpower development on avian and bat resources.

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INTRODUCTION

A baseline study of avian resources using the proposed Vansycle Ridge windplant in Umatilla County, Oregon was conducted in 1995 (Woodward-Clyde Consultants and Western EcoSystems Technology, Inc., 1997). The baseline study provided an estimate of relative abundance of avian species over an area of approximately 50,765 acres (the Vansycle Wind Resource Area), which included the Vansycle Ridge windplant site. The study also documented nesting activity by raptors in an area potentially influenced by wind power development within the entire WRA. Data collected during the baseline study indicated that the study area was not a high avian use area during either spring or fall migration. Raptor use within the Vansycle Wind Resource Area was found to be lower than raptor use at most other wind resource areas where comparable data exist.

In December 1998, FPL Energy completed development of a 24.9 MW wind plant on Vansycle Ridge. The windplant is comprised of 38 660-kilowatt Vestas turbines and related facilities, including distribution lines, meteorological (met) towers, communication systems, transformers, a substation, roads, and operations and maintenance facilities. The turbines are arranged in two strings, with 28 turbines on String A and 10 on String B. Most of the project area is cultivated for wheat. One turbine block in Area A is grassland. The north edge of several turbine blocks includes approximately 10 m to 12 m of grassland. This edge is primarily non-native grasses which were seeded several years earlier when the strip was registered in the Conservation Reserve Program. Native grassland is found on the slopes to the north of the turbine blocks. This habitat is primarily bunchgrass, cheatgrass and weedy forbs. Area B is approximately half wheat and half grassland. Much of this grassland is disturbed and very weedy. Photographs showing major habitat types in the study area are provided in Figure 1.

Carcass searches to locate dead birds and bats were initiated in January 1999. The objective of the carcass searches was to estimate the number of avian and bat fatalities attributable to windplant features at the Vansycle Ridge Wind Farm. This report presents results of the 1999 annual carcass search study.

METHODS

Carcass Searches

Mortality was measured by estimating the number of bird and bat carcasses in the wind development area whose death could be related to turbines and met towers. 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 and necropsy results. An estimate of

the total number of carcasses was made. The total number of carcasses was estimated by adjusting for "length of stay" (scavenging) and searcher efficiency bias.

Carcass searches were conducted at half the turbines once every two weeks during the study, with all turbines searched each 28-day period. Biologists trained in proper search techniques conducted the searches. Data collected by Higgins *et al*. (1996), Johnson *et al*. (1999a, 1999b), Orloff and Flannery (1992) as well as other windpower researchers have indicated that most birds and bats striking turbines remain within 63 m of the turbine. Permanent rectangular plots 126 m in width were established on strings of turbines within the windplant to ensure all areas within 63 m of each turbine were searched (Figure 2). Square or rectangular plots were used instead of circular plots to facilitate marking search boundaries and conducting the search. Transects were initially set at 6 m apart in the area to be searched, and the searcher initially walked at a rate of approximately 45-60 m/min along each transect searching both sides out to 3 m for casualties (Johnson *et al*. 1993). Transect width and search speed were adjusted based on visibility within the various habitats and crop stages. On average, approximately 30 to 60 minutes were spent searching each turbine per search, depending on habitat. Carcasses found while conducting other study activities were also recorded.

For all casualties found, data recorded included species, sex and age when possible, date and time collected, location, habitat, condition, and any comments which may indicate time and cause of death. The condition of each carcass found was recorded using the following condition categories:

- Intact - carcass that is completely intact, is not badly decomposed, and shows 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 portion(s) of a carcass 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 casualties located were photographed as found and mapped on a detailed map of the study area which showed the location of windplant facilities. Casualties were labeled with a unique number, bagged and frozen for future reference and possible necropsy. Suitable carcasses were necropsied by Dr. Elizabeth Williams of the Wyoming State Veterinary Laboratory in Laramie, Wyoming. Carcass searches were not conducted on reference plots and no estimates

of background mortality in the study area are available. Therefore, all carcasses and carcass parts found where the cause of death was not apparent were considered windplant related, which likely results in overestimating 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 for the period of study, and k is the number of search periods. The variance was calculated by:

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

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

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

with variance

$$V(C) = k^2 * V(\bar{c}).$$

Carcass Search Biases

Estimation of Carcass Removal

The objective of the carcass removal trials was to estimate the length of time avian casualties remain in the search area prior to being removed. Carcass removal includes removal by predators, scavengers or other means, such as being plowed into a field. Two carcass removal trials were conducted during each of the following seasons: (1) winter (January 1-March 31); spring (April 1 - June 30); (2) summer (July 1-September 30); and (3) fall (October 1-December 31). Planted carcasses were placed from 5 m to 25 m off of carcass search plots to minimize the probability that they would be confused with wind turbine related mortalities, especially if they had been scavenged. The planted carcasses were located at random locations.

Each season, 10 carcasses of birds of two size classes were distributed resulting in a total of 80 trial carcasses used in carcass removal studies for the entire year. Small carcasses (e.g., Brewer's blackbird, juvenile northern bobwhite) were used to simulate passerines and large carcasses (e.g., female ring-necked pheasants, mallards, owls) were used to simulate large birds such as raptors and waterfowl. Approximately five carcasses from each size class (10 total carcasses) were placed in the field during each of two trials each season. Thus, the trials were spread throughout the year to incorporate the effects of varying weather, climatic conditions, farming practices, and scavenger densities.

Carcasses were placed in a variety of postures to simulate a range of conditions. For example, birds were: (1) placed in an exposed posture (e.g., thrown over the left shoulder), (2) hidden to simulate a crippled bird (e.g., placed beneath a shrub or tuft of grass), and (3) partially hidden. Carcasses were checked over a period of 28 days to determine scavenger removal rates. Carcasses were scheduled to be checked every day for the first 4 days, and on days 7, 10, 14, 20, and 28. Some modifications were made to the schedule due to inclement weather. At the end of the 28-day period all remaining birds were removed. Carcasses were discreetly marked with dull-colored tags 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 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:

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

Carcass removal statistics were estimated by season and size class of bird. Because a significant 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).

Searcher Efficiency Trials

The objective of searcher efficiency trials was to estimate the percentage of avian casualties found by searchers. To maintain consistency in the carcass search effort, only two people were used throughout the study. Searcher efficiency studies were conducted in the same areas carcass searches occurred. Estimates of searcher efficiency (carcass detection rate) were used to adjust the number of carcasses found, correcting for detection bias. Carcasses used for searcher efficiency trials had the same composition as those used for carcass removal trials.

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. For each trial, approximately 10 carcasses of birds of two different size classes (small, large) were placed in the search area throughout the search period for the searcher to either detect or not detect. Carcasses were placed in a variety of postures to simulate a range of conditions as was done for scavenger removal trials. Each carcass was discretely secured at its location to discourage removal by scavengers. Carcasses were discreetly marked (see scavenger removal studies) so that they could be identified as a study carcass after being found. The number and location of the detection carcasses found during the carcass search were recorded. The number of carcasses available for detection during each trial was verified immediately after the trial to ensure that no carcasses were removed by scavengers between the time they were placed and the carcass search on that day. Carcasses not found by the searcher were removed following the carcass search effort for that day.

Searcher efficiency was expressed as p, the estimated proportion of 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:

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

where k is the total number of carcasses placed, and p is the proportion of carcasses found by searchers. Searcher efficiency was estimated by season, carcass size class and major habitat.

Estimation of the Total Number of Fatalities

Estimation of the total number of fatalities consists of the three components discussed previously: (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.

The estimated total number of carcasses for the windplant, *m*, for the period of study was calculated by:

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

where *N* is the total number of turbines, *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 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:

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

From this, the variance of *m* is:

$$V(m) = I^2 * m^2 * \left[\frac{V(\bar{t} * p)}{\bar{t} * \bar{p}^2} + \frac{V(C)}{C^2} \right].$$

The standard error of *m* is calculated by

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

An approximate 95% confidence interval around *m* is:

$$m \text{ " } 2*SE(m).$$

RESULTS AND DISCUSSION

Avian Fatalities

Twelve avian fatalities were found on the Vansycle windplant during the 1999 annual carcass searches. The 12 avian casualties were comprised of at least six species. Seven of the casualties found (58%) were passerines. The most common passerine found was white-crowned sparrow, with four casualties. Other passerine species found included one white-throated swift, one horned lark, and one unidentified sparrow. Other avian species found included one Lewis' woodpecker, two gray partridge, one chukar and one unidentified partridge (Table 1). With the exception of the Lewis' woodpecker, which is classified as a sensitive species in Oregon, all avian species found appear to be relatively common in the state.

Seven of the avian casualties (58%) were scavenged, four (33%) were feather spots, and one (8%) was intact. Ten of the casualties were found during scheduled carcass searches and the remaining two were incidental finds. All carcasses found during the study were used to estimate mean number of carcasses per study plot and total windplant mortality. Avian casualties were found from 3 m to 76 m away from turbines, and the mean distance was 37.0 m. Avian casualties were found at 11 of the 38 turbine plots (Figure 2). Only one turbine (A9) had more than one avian casualty, with two.

Casualty data indicate that passerine migrants and resident upland gamebirds appear most prone to turbine collisions on Vansycle Ridge. Based on the time period each passerine casualty was found, it is likely that all four white-crowned sparrows and the unidentified sparrow were migrating through the area. The white-throated swift and horned lark were likely summer breeders and the Lewis' woodpecker may have been a migrant or resident breeder. The four partridges are introduced gamebirds that are permanent residents on the study site.

Weather did not appear to be strongly related to avian mortality. Of the 12 bird casualties found during the study, eight were estimated to have been dead for less than one week, which allowed weather at the estimated time of death to be recorded. Six of these likely collided with turbines when weather conditions were not severe (e.g., no strong winds, rain, or fog), one may have collided with a turbine during gusty winds, and one may have collided with a turbine during a rainstorm.

Bat Fatalities

Ten bat fatalities were found during the 1999 annual carcass searches. Species found included hoary bat (5), silver-haired bat (3), and little brown bat (1). One bat was reported by a maintenance worker but was not relocated. Based on the description provided, it was likely a hoary bat. Hoary and little brown bats are relatively common in Oregon, but the silver-haired bat is considered a sensitive species in the state. Whereas bird fatalities were found throughout the year, bat casualties were all found during the period from 23 August to 21 September 1999 (Table 1). Five of the bats were found during scheduled carcass searches; the remainder were incidental discoveries. Incidental discoveries consisted of one bat found by a windplant maintenance worker and four bats found by study personnel. All carcasses found were used to estimate mean number of carcasses found per study plot and total windplant mortality. Bats were found at eight of the 38 turbine plots searched. The largest number of bats found at any one turbine was three at turbine A27 (Figure 2). Two of the bats were intact, seven were scavenged and one was dismembered. Most of the scavenging was done by insects. Distances that dead bats were found from turbines ranged from 1.96 m to 36.2 m, and the average was 14.2 m. All of the bats were found when weather conditions were mild.

No data on habitat use or behavior of bats in the Vansycle Ridge study area have been collected as part of wind development area monitoring activities. Hoary and silver-haired bats roost in deciduous trees. Little brown bats also roost in trees, but may roost in other habitats including rock crevices, wood piles, buildings and other structures (Clark and Stromberg 1987). Bat roost sites in the project area likely include nearby riparian areas. Hoary and silver-haired bats are migratory species. These bats migrate north in May and June, and begin their southward movement in late August or early September (Fitzgerald *et al*. 1994). The little brown bat spends the winter in hibernacula, and may migrate 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. Silver-haired bats spend most of their time foraging at heights less than 6 m, and little brown bats generally forage at heights of 1.5 to 6 m near or over water.

Carcass Search Biases

Searcher Efficiency

Eighty-two birds (40 large, 42 small) were placed for searcher efficiency trials during the 1999 annual study. Carcasses used to represent large birds included ring-necked pheasant, great horned owl, red-tailed hawk, barn owl, Cooper's hawk, gray partridge, long-eared owl, bantee

chicken, and mallard. Carcasses used to represent small birds included northern bobwhite, Brewer's blackbird, mourning dove, common nighthawk, northern saw-whet owl, red-winged blackbird, and American robin. Trial birds were obtained from a variety of sources. A Special Purpose Salvage Permit was issued by the US Fish and Wildlife Service and a Scientific Taking Permit was issued by Oregon Department of Fish and Wildlife. Game birds were purchased from local game farms. Raptors were obtained from FPL Energy, Inc. at the Altamount Pass wind project in California, the Five Mile Creek Raptor Center in California, the Pendleton office of the Oregon Department of Fish and Wildlife, and from a local wildlife rehab center. Some birds were roadkills found at various locations in Umatilla County.

Searcher efficiency varied by season, habitat and size class of bird. Searchers detected 50.0% of the small birds and 87.5% of the large birds. For both size classes combined, searcher efficiency ranged from 59.1% in spring to 86.7% in winter. Searcher efficiency was lowest in grassland (56.7%) and highest in wheat stubble (76.0%) (Table 2). The overall searcher efficiency for all size classes, habitats, and seasons combined was 68.2%.

Carcass Removal Rates

Eighty carcasses (40 large, 40 small) were used for scavenger removal trials during the study. Large carcasses lasted an average of 26.7 days, and small carcasses lasted an average of 23.4 days (Table 2). Carcasses lasted the longest in the summer (39.8 days), followed by winter (26.5 days), fall (23.3 days) and spring (18.1 days) (Table 2). Trial carcasses had similar composition to those used in searcher efficiency trials. The overall mean length of stay for all carcasses and seasons was 25.0 days. Species observed in the project area that may scavenge carcasses include raptors, ravens, coyotes, badgers, mice and insects. During summer, one of the main causes of carcass removal was scavenging by insects, including carrion beetles and maggots.

Estimation of the Number of Windplant-Related Fatalities

Searcher efficiency and scavenging rate (length of stay) data were pooled across seasons for calculating the total number of avian fatalities. Only searcher efficiency and scavenger removal data collected in the summer and fall for small birds were used to estimate the total number of bat fatalities. Trials conducted with bats at the Buffalo Ridge windplant in Minnesota indicate that both searcher efficiency and scavenger removal rates are similar for bats and small birds (WEST, Inc., unpublished data). Based on these calculations, the total number of turbine-related casualties in 1999 for the Vansycle Ridge windplant was estimated to be 24 birds (95% confidence interval [CI]= 22-26) and 28 bats (95% CI = 10-59). The

estimated fatality rate per year was estimated to be 0.63 birds/turbine (95% CI = 0.60 - 0.66) and 0.74 bats/turbine (95% CI = 0.26 – 1.56) (Table 4). Confidence intervals for bat fatality estimates were wider than those for birds due to the higher variability in the number of bat fatalities found per search. Avian mortalities were found throughout the year, whereas all bat mortalities were concentrated in a few search intervals.

Most of the windplant-related avian casualties on Vansycle Ridge were passerines, and many of these were likely nocturnal migrants. No raptor casualties were found during the study period. Due to the low scavenger removal rate and high searcher efficiency for large carcasses, it is likely that no raptors or other large birds besides the chukar and gray partridge were killed during the study period. Mortality of large birds was apparently limited to chukars and gray partridge, two introduced upland gamebirds.

Data collected indicate that avian mortality appears to be relatively low on Vansycle Ridge. Avian fatality rates on the Vansycle Ridge project (0.63/turbine) are much lower than those reported at some windplants in California as well as windplants in Minnesota, where annual mortality was estimated to be 1.95 birds/turbine (Johnson *et al*. 1999a), and in Wyoming, where annual mortality was estimated to be 1.99 birds/turbine (Johnson *et al*. 1999b). The estimated number of bats killed per turbine at Vansycle Ridge (0.74) is also much lower than annual bat fatality estimates for windplants in Minnesota (2.3/turbine) (Johnson *et al*. 1999a) and Wyoming (2.48/turbine) (Johnson *et al*. 1999b). We are not aware of any other studies that have quantified bat fatality rates at windplants in the U.S. Overall results of the carcass search studies indicate that the monitoring protocol used for this study is sufficient to provide data required to adequately evaluate effects of windpower development on avian and bat resources.

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Table 1. Avian and bat mortalities found on the Vansycle Wind Project in 1999.

BIRDS

Log #	Species	Date	Turbine	Distance to Turbine (m)	Habitat[a]	Found During Carcass Search	Comments
1	White-crowned Sparrow	4-30-99	A-9	50	Grassland	Yes	Feather Spot with one half of a wing[b]
2	White-crowned Sparrow	5-10-99	A-9	14	Wheat	No	Intact with fractured skull and wings
3	White-crowned Sparrow	5-11-99	A-24	76	Wheat	Yes	Scavenged with wing and body feathers
4	White-throated Swift	7-31-99	A-17	47	Wheat	Yes	Scavenged with no obvious signs of trauma[b]
5	Gray Partridge	8-3-99	A-4	12.7	Wheat	Yes	Feather Spot consisting of two primaries
6	Lewis' Woodpecker	8-5-99	B-3	16.5	Grassland	Yes	Scavenged, desiccated with fractured wing[b]
18	Horned Lark	9-21-99	B-5	20	Grassland	No	Scavenged with fractured skull, desiccated
19	Chukar	10-6-99	A-6	51	Grassland	Yes	Scavenged, head and neck, legs, wing present
20	Unidentified Sparrow	10-10-99	B-1	38.5	Grassland	Yes	Feather Spot with wing and breast feathers
21	Gray Partridge	10-21-99	A-7	3	Wheat Stubble	Yes	Scavenged
22	White-crowned Sparrow	10-22-99	B-6	57	Grassland	Yes	Scavenged, primaries missing from one wing
23	Unidentified Partridge	11-18-99	A-16	58	Wheat Stubble	Yes	Feather Spot

BATS

Log #	Species	Date	Turbine	Distance to Turbine (m)	Habitat	Found During Carcass Search	Comments
7	Hoary Bat	8-23-99	A-17	36.2	Wheat Stubble	Yes	Dismembered, missing wing, body abrasions
8	Hoary Bat	8-24-99	A-11	18.8	Wheat Stubble	Yes	Scavenged, desiccated[b]
9	Hoary Bat	8-24-99	A-8	4.6	Wheat Stubble	No	Scavenged, desiccated
10	Hoary Bat	8-24-99	A-27	12.5	Wheat Stubble	No	Scavenged, desiccated
11	Little Brown Bat	9-13-99	A-25	4.1	Wheat Stubble	Yes	Scavenged with injuries to leg and abdomen
12	Hoary Bat	9-13-99	A-27	16.85	Wheat Stubble	Yes	Scavenged with no obvious injuries
13	Silver-haired Bat	9-13-99	A-4	1.96	Wheat Stubble	No	Scavenged, desiccated with fractured wing
14	Unidentified Bat	9-13-99	B-?	13	Wheat Stubble	No	Intact - reported by maintenance worker along B string but not relocated by study personnel
15	Silver-haired Bat	9-19-99	A-27	16.96	Wheat Stubble	No	Intact with fractured wing
17	Silver-haired Bat	9-21-99	B-7	17.35	Wheat Stubble	Yes	Scavenged with torn wing membranes

[a] Photographs of habitat types are presented in Figure 1

[b] These specimens were submitted to the Wyoming State Vet Lab for necropsy

Table 2. Searcher efficiency rates by habitat, season, and size class of bird

Size Class/Season	Habitat[a]			Total
	Wheat	Wheat Stubble	Grassland	
Large Birds				
Winter	4/4 (100.0%)	NA[b]	1/2 (50.0%)	5/6 (83.3%)
Spring	6/6 (100.0%)	NA	4/5 (80.0%)	10/11 (90.9%)
Summer	2/2 (100.0%)	6/6 (100.0%)	1/3 (33.3%)	9/11 (81.8%)
Fall	NA	8/8 (100.0%)	3/4 (75.0%)	11/12 (91.7%)
Total	12/12 (100.0%)	14/14 (100.0%)	9/14 (64.3%)	35/40 (87.5%)
Small Birds				
Winter	2/2 (100.0%)	NA	6/7 (85.7%)	8/9 (88.9%)
Spring	3/10 (30.0%)	NA	0/1 (0.0%)	3/11 (27.3%)
Summer	3/3 (100.0%)	3/3 (100.0%)	1/3 (33.3%)	7/9 (77.8%)
Fall	NA	2/8 (25.0%)	1/5 (20.0%)	3/13 (23.1%)
Total	8/15 (53.3%)	5/11 (45.4%)	8/16 (50.0%)	21/42 (50.0%)
All Birds				
Winter	6/6 (100.0%)	NA	7/9 (77.8%)	13/15 (86.7%)
Spring	9/16 (56.3%)	NA	4/6 (66.7%)	13/22 (59.1%)
Summer	5/5 (100.0%)	9/9 (100.0%)	2/6 (33.3%)	16/20 (80.0%)
Fall	NA	10/16 (62.5%)	4/9 (44.4%)	14/25 (56.0%)
Total	20/27 (74.1%)	19/25 (76.0%)	17/30 (56.7%)	56/82 (68.2%)

[a] Photographs of habitat types are presented in Figure 1

[b] NA = no trials conducted

Table 3. Estimated mean length of stay (days) for carcasses placed to monitor scavenger removal rates.

Carcass Size Class	Season	N	% remaining at 28 days	mean length of stay (days)
Large	Spring	10	30.0	17.3
	Summer	10	70.0	39.7
	Fall	10	40.0	24.0
	Winter	10	80.0	31.1
	Total	40	55.0	26.7
Small	Spring	10	70.0	18.9
	Summer	10	70.0	39.9
	Fall	10	30.0	22.9
	Winter	10	40.0	19.9
	Total	40	42.5	23.4
All Carcasses	Spring	20	50.0	18.1
	Summer	20	70.0	39.8
	Fall	20	35.0	23.3
	Winter	20	60.0	26.5
	Total	80	48.8	25.0

Table 4. Estimates of windplant-related fatalities for the Vansycle Ridge windplant, 1999.

Turbine Fatalities					
BIRDS					
Carcass Size	Number Found	Estimated Total Mortality	95% CI	Estimated #/turbine/year	95% CI
Large	4	5	4 – 6	0.13	0.12 - 0.14
Small	8	19	18 – 21	0.50	0.48 - 0.53
TOTAL	12	24	22 – 26	0.63	0.60 - 0.66
BATS					
Small	10	28	10 – 59	0.74	0.26 – 1.56

Figure 1. Photographs of Vansycle Ridge study area (© Karen Kronner)

Plowed Wheat Field - Late Fall

Emerging Wheat – Late Winter

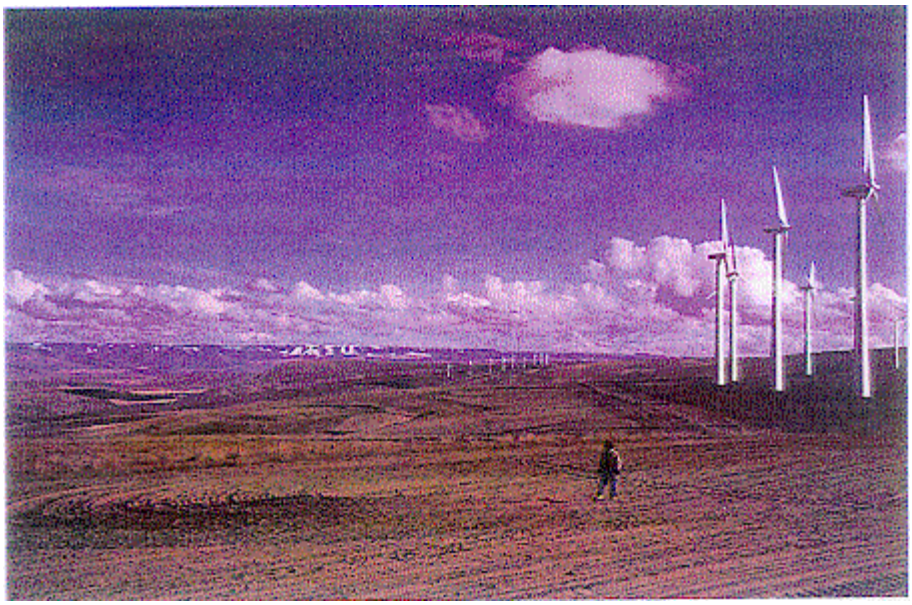


Figure 1 (Continued). Photographs of Vansycle Ridge study area (© Karen Kronner)

Wheat Field – Late Spring

Wheat Field – Summer

Figure 1 (Continued). Photographs of Vansycle Ridge study area (© Karen Kronner)

Wheat Field Stubble After Harvest – Early Fall

Weedy Grassland

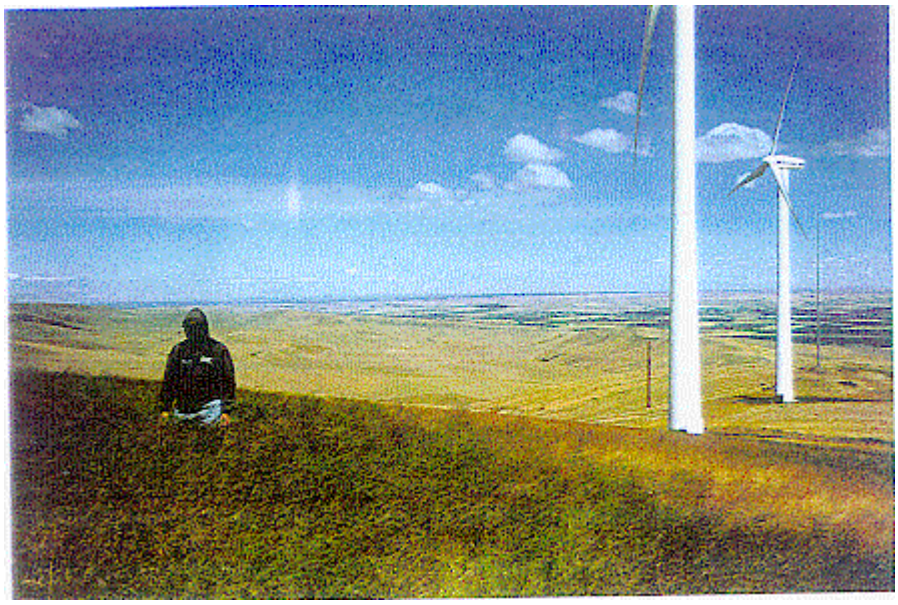
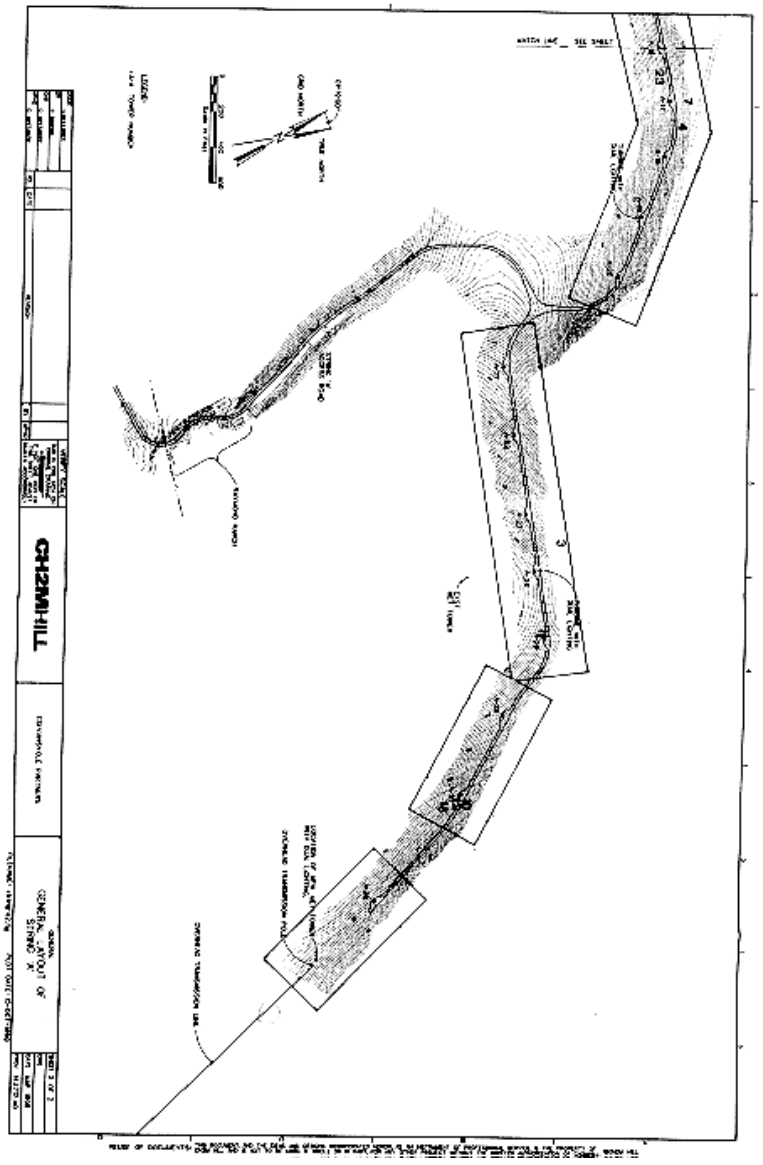
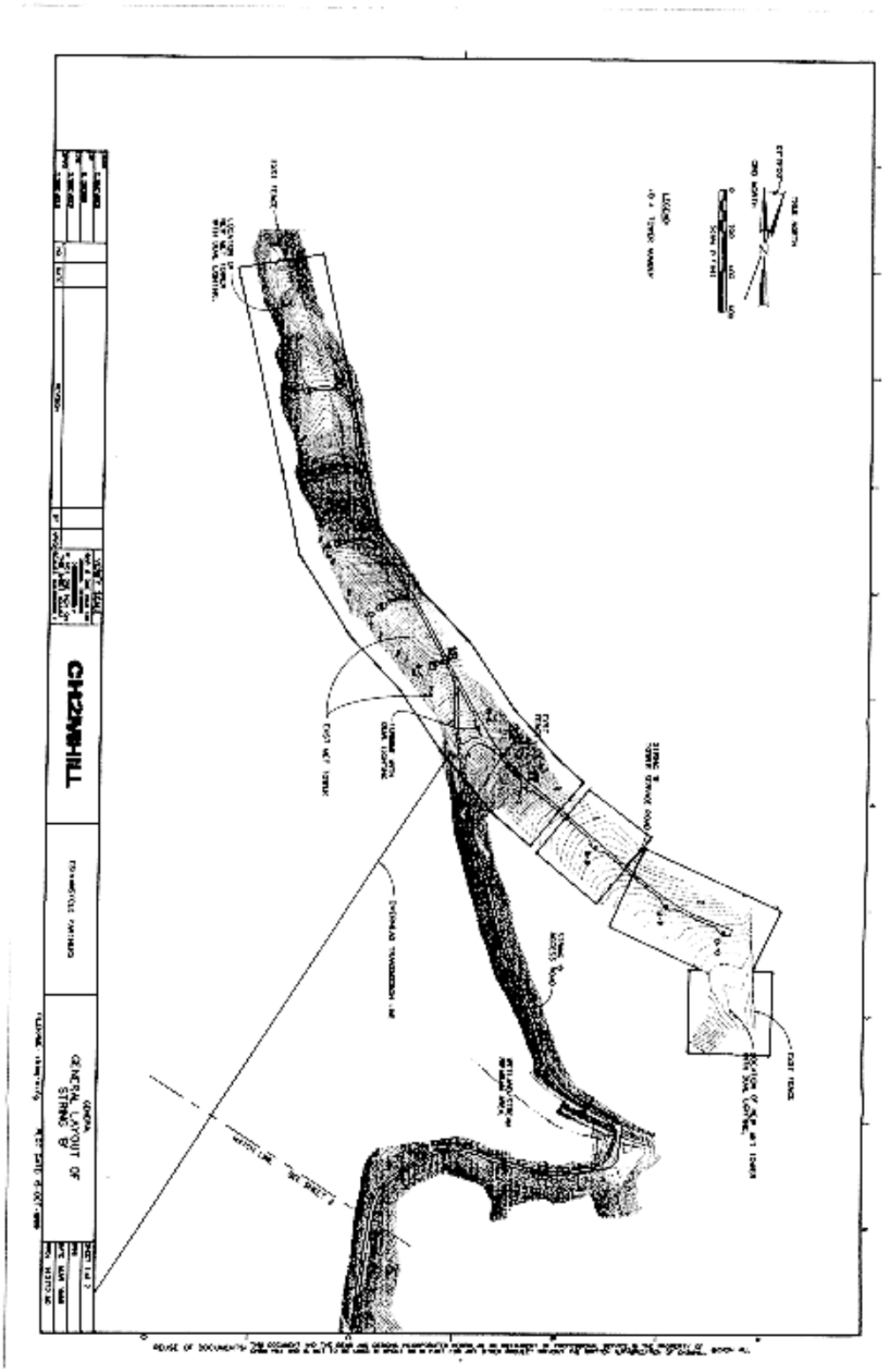


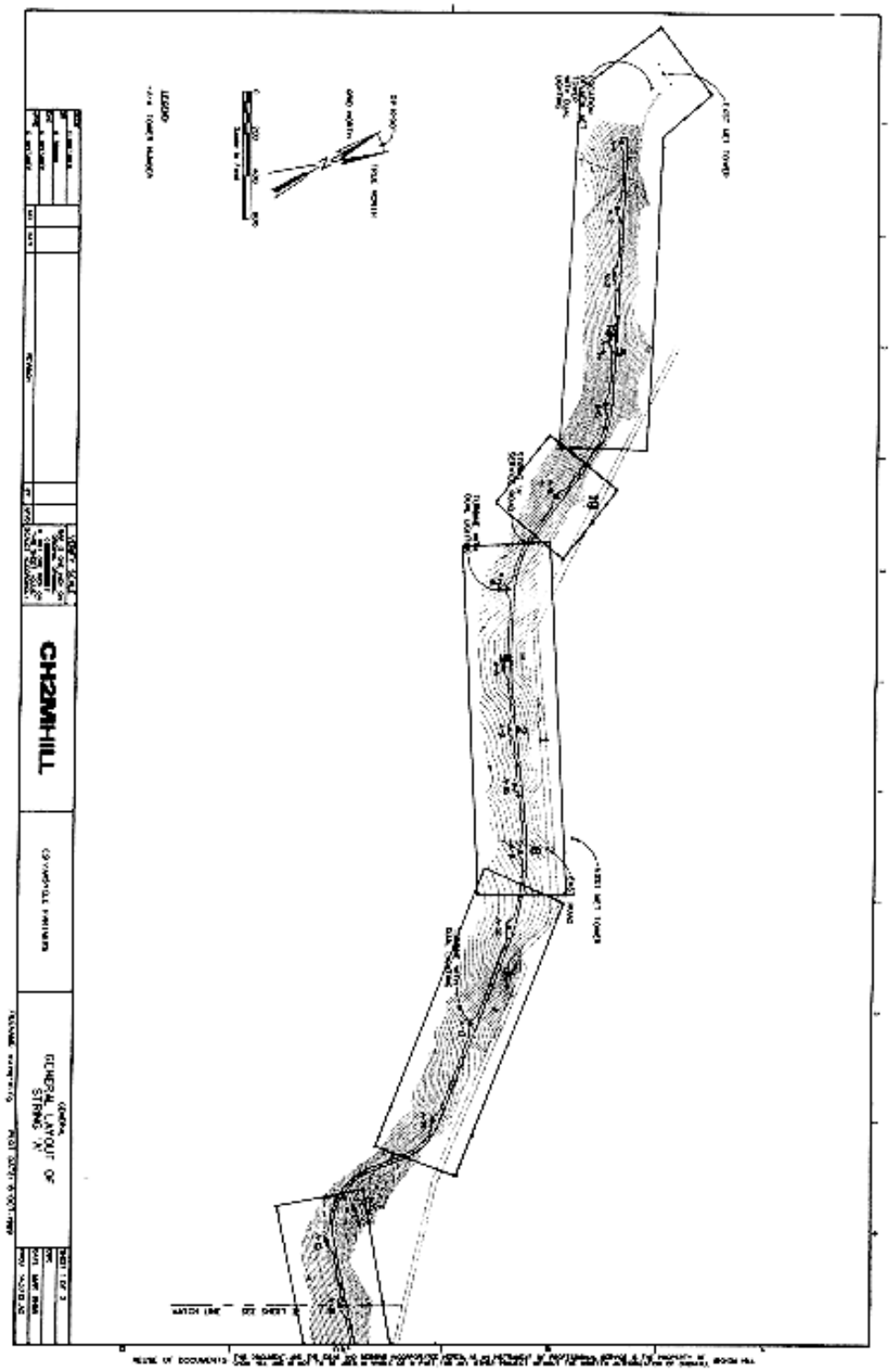
Figure 1 (Continued). Photographs of Vansycle Ridge study area (© Karen Kronner)

Grassland and Disturbed Areas Along Access Roads

Figure 2. Location of carcass search plots and fatalities located during the study (fatality numbers correspond to log numbers in Table 1).






CH2MHILL
GENERAL LAYOUT OF STRING 'A'