BEFORE THE STATE OF WASHINGTON

ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of Application No. 2009-01 of WHISTLING RIDGE ENERGY LLC for WHISTLING RIDGE ENERGY PROJECT	EXHIBIT NO. 22.00 PREFILED DIRECT TESTIMONY OF K. SHAWN SMALLWOOD, PH.D

PREFILED DIRECT TESTIMONY OF WITNESS #22
K. SHAWN SMALLWOOD, PH.D

ON BEHALF OF

INTERVENORS FRIENDS OF THE COLUMBIA GORGE
AND SAVE OUR SCENIC AREA

Q. Please state your name and business address.

A. My name is K. Shawn Smallwood, and my business address is 3108 Finch Street, Davis, CA 95616.

Q. What are your professional occupation, experience, and areas of expertise?

A. I am an ecologist with 25 years of research and consulting experience on issues related to wildlife management and conservation problems. My curriculum vitae is marked for identification as Exhibit No. 22.01. I received a Ph.D. degree in ecology from the University of California at Davis in 1990. Following four years of post-graduate research in the Agronomy and Range Science Department at UCD, I have worked for citizen

groups, businesses, attorneys, and government agencies, largely on solving problems affecting wildlife, especially on special-status species.

I have eleven years of experience with the biological impacts caused by wind turbines. I performed multiple monitoring and research programs in the Altamont Pass Wind Resources Area (APWRA), and I senior authored many reports that followed, most of which were peer-reviewed. I consulted for the California Energy Commission on matters related to wind farm development. I also consulted to wind power companies, and helped project applicants obtain permits to repower portions of the APWRA. My contribution to wind energy development has been to produce research-based solutions to avoiding, minimizing, and reducing bird collisions with wind turbines.[1]

Q. What information related to the proposed Whistling Ridge Energy Project have you reviewed to date?

A. I have reviewed the sections and appendices of the Whistling Ridge Energy Project Application for Site Certification and the sections and appendices of the Draft Environmental Impact Statement for the Project pertaining to natural resource impacts. I have also reviewed the prefiled direct testimony and exhibits of Greg Johnson and Jeff Reams.

Q. Is the information contained in the materials you reviewed within your area of authority and/or expertise?

A. Yes.

Q. Did the evidence that the Application relied upon to estimate wind turbine impacts give you any cause for concern?

A. Yes. The Application appears to have relied on several types of empirical evidence to predict wind turbine-caused impacts at the proposed 75 MW Whistling Ridge wind energy project. These lines of evidence included a model based on fatality rates regressed on utilization rates, comparisons of exposure index values among species seen at the site, and a comparison of raptor nest density to nesting densities at other wind project sites. However, these approaches have led to inaccurate predictions of project impacts at other locations, and therefore should be examined carefully before relying on them yet again.

Q. Have you analyzed predictions of raptor fatality rates at wind projects in Washington, Oregon, and California, and if so, what conclusions have you reached through this analysis?

A. Yes. Most predictions of raptor fatality rates at wind projects have been proven wrong after the project was developed and monitored for fatalities, and some of the wrong predictions have been very wrong (Table 1). Following construction and monitoring, raptor fatalities were estimated to be twice as high as predicted at Stateline, nearly 6 times higher than predicted at Hopkins Ridge, 3 times higher than predicted at Wild Horse, 7 times higher than predicted at Shiloh I, at least 11 times higher than predicted at Klondike II, and about 14 times higher than predicted at Big Horn (see Exhibit 22.03). Even in the scientific field of wildlife biology, prediction errors of these magnitudes would be considered gross failures. Prediction failures are caused by fundamental shortfalls in the assumptions and methodology used to make the predictions.[2] The repeat failures to predict wind project impacts should prompt the States of Washington and Oregon to demand a review of the methods used, and to require new standards, including consequences for wind projects exceeding predicted fatality levels by more than 50%.

	Raptor fatalities / MW / Year			**How fatality rates compared to predicted rates**
Project	**Predicted**	**Reported estimate**	**Smallwood estimate**	
Klondike I	0.029 - 0.044	0.000	0.000	Lower
Combine Hills	0.00-0.02	0.000	0.000	Accurate
Buena Vista[a]	0.331-0.581	0.605	0.544	Accurate
Klondike II	~0	0.11	0.062	≥11 times higher
Stateline	0.061	0.091	0.130	1.5 to 2.1 × higher
Big Horn	0.015 – 0.020	0.150	0.243	8.6 to 13.9 × higher
Shiloh I	0.109	0.820	0.756	6.9 to 7.5 × higher
Wild Horse	0.007-0.074	0.090	0.128	2.2 to 3.2 × higher
Tuolumne	0.05-0.16	0.29	0.27	2.6 to 2.8 × higher
Hopkins Ridge	0.020-0.040	0.139	0.172	4.6 to 5.7 × higher

[a] I co-authored the report that presented the predicted fatality rates for Buena Vista.

Table 1. *Predictions of raptor fatality rates at proposed wind projects, and compared to estimated fatality rates following project development. Reported estimates were those appearing in fatality monitoring reports provided by consultants, and the Smallwood estimates were those made by me, using a common set of methods and assumptions, including search detection and scavenger removal rates reported in Smallwood (2007).*

Q. What are your conclusions about WEST, Inc.'s predictions of fatality rates based on project utilization rates?

A. WEST, Inc. relied on a regression relationship (*Figure 8* in DEIS App. C-4) that regularly appears in WEST's environmental documentation in support of wind energy projects, and which I have commented on before (see Figure 1, below). Affirming its reliance on the WEST, Inc. approach to assessing potential project impacts, the DEIS (page 3-63) stated, "*Mean overall bird use in the study area was low compared to these other wind resource areas studied: ranking 19th compared to 24 other wind resource areas…*" and, "*Mean annual raptor use was 0.28 raptors per plot per 20-minute survey, which is a standardized way to measure use in order to compare results to avian use at other sites.*" However, this approach was inappropriate for use as a predictive tool due to multiple fundamental flaws, which are addressed in the following paragraphs.

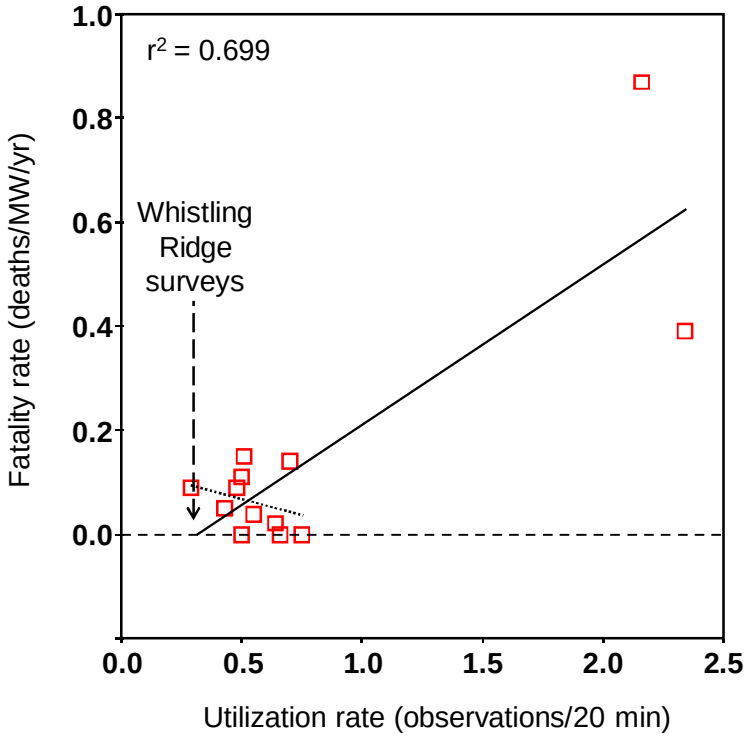

Figure 1. *Fatality rate as a function of utilization rate, according to WEST, Inc., Figure 8 in DEIS Appendix C-4. The dotted line fitting the clump of data points at the lower left represents an alternative regression relationship if data from the two California WRAs in the upper right aspect of the graph were omitted. The regression relationship was pseudoreplicated.*

The regression relationship in *Figure 8* of DEIS App. C-4 exemplifies psuedoreplication in correlation analysis, which is a fundamental experimental design flaw that is routinely warned against in statistics textbooks.[3] The regression is based on two clusters of data, one from wind projects located mostly in the Pacific Northwest and the other from two projects located nearby each other in California. If the variation in the graph was more representative of the two regions—Washington/Oregon versus Central California—than of the individual project sites, then the sampling units were really the regions and not the project sites.

In presenting their graph, Johnson and Erickson (2008, 2010) presented a value for the coefficient of determination, r^2, but they neglected to present an error term. Furthermore, they presented the relationship as significant, and the DEIS repeated that conclusion along with the prediction, based on the regression, that 0 raptors would be killed by Whistling Ridge wind turbines (page 3-79).

The coefficient of determination is an index of both response and precision, but the reader must be familiar with regression analysis to visually assess the degrees to which variability or precision contributed to r^2. A more direct measure of precision is the root mean square error (RMSE) of the regression, otherwise known as standard error. In my experience, RMSE can serve as a diagnostic tool for deciding whether r^2 was influenced more by leveraging from outliers or from psuedoreplication. Another diagnostic test is to omit data from one of the clusters to learn whether the regression slope would change significantly. In fact, omitting the two data points from Central California project sites converted a strongly positive slope to a negative slope (see dotted line in Figure 1), and the revised regression line was a better fit to the data, based on RMSE (RMSE = 0.0567, which was a third of the value for the pseudoreplicated regression slope). In cases like this, when two data points determine whether an estimated regression slope is strongly positive or negative, the analyst should not use the regression equation to make predictions. It was inappropriate to predict that 0 raptors would be killed by Whistling Ridge.

Q. Greg Johnson states in his testimony (Exhibit No. 6.00), "To date, the relationship between raptor use and mortality has been fairly consistent across habitats and locations, and these data represent the best available science for predicting avian impacts at the project site." Does this statement change your opinion about the utility of Figure 1?

A. No. The relationship purported by Johnson is represented in a graph that WEST, Inc. has repeatedly used, but which has not been peer-reviewed or published in the scientific literature. Just because a consulting firm repeatedly uses the same graph does not mean that the purported relationship is consistent across habitats and locations. Furthermore, the utilization surveys contributing to the data in Figure 1 were often inconsistent with

current protocols and best scientific practices. For example, they often lasted less than one full year, in contrast with the recommendations of the WDFW Guidelines[4] and U.S. Fish and Wildlife Service Wind Turbine Guidelines Advisory Committee.[5] Also, no effort was made to measure vegetation or topography at survey sites, which is recommended by the U.S. Fish and Wildlife Service Wind Turbine Guidelines Advisory Committee for the purpose of comparability.

Furthermore, inter-annual variation in both fatality rates and utilization rates at a given project site can easily exceed the range of variation depicted between project sites in the graph. For example, the year used to represent Diablo Winds data (the highest data point in the graph) was the peak year within a 10-year span of monitoring for raptor fatalities and raptor utilization in the Altamont Pass. Raptor fatalities caused by Diablo Winds were 5.7 times more frequent in the Altamont Pass that year than during the year with the lowest fatality rate. Similarly, the raptor utilization rate observed amongst the Diablo Winds turbines that year was 3 times greater than during the low year. Had Johnson used the low fatality and utilization year instead of the peak fatality and utilization year, then the data point representing Diablo Winds would have been nearer those represented by the Oregon and Washington wind projects.

Q. What are your conclusions about the sufficiency of the survey efforts for the Project?

A. The vertical dashed arrow in Figure 1 represents the utilization rate that WEST, Inc. estimated for raptors at the Whistling Ridge project site. Although a non-biologist might be impressed with the number of bird surveys performed at the Whistling Ridge project site, totaling 261 surveys, biologists familiar with utilization surveys at wind project sites have cause for concern regarding conclusions drawn from the level of effort devoted to Whistling Ridge. The 261 surveys lasted 20 minutes each, so totaled 87 hours. Eighty-seven hours was insufficient time to detect multiple raptor species and many other bird species, especially considering the high levels of visual occlusion due to forest cover surrounding observation stations at Whistling Ridge, along with the large volumes of airspace that would have been occluded due to mountainous terrain and cloudiness.

Even the large amount of survey time invested in the Altamont Pass WRA -- where no forest occluded views -- failed to detect multiple species that are killed by APWRA wind turbines, including threatened and endangered species such as brown pelican and peregrine falcon, and many hours were needed to detect only one individual of many species. For example, 774 hours of survey at Vasco Caves Regional Preserve in the Altamont Pass WRA[6] failed to detect peregrine falcon even though this species was twice documented as killed by Altamont Pass wind turbines. At Vasco Caves, it took 387 hours per observation of merlin, even though this species is killed by Altamont Pass wind turbines. It took all 774 hours to detect one red-shouldered hawk, and it took 70 hours per Cooper's hawk

observation and 55 hours per Swainson's hawk observation, even though members of these species have been killed in the Altamont Pass. Just because a species goes undetected in the minimal survey efforts that have been directed to birds at wind project sites does not mean that that species will avoid collisions with wind turbines. This is likely one of the reasons why the WDFW Guidelines (§ 1.5) recommend surveying project sites for two or more years when avian groups of concern are at risk, where data on seasonal use are lacking, or where species diversity is high. All three of these conditions often apply where wind projects are proposed, because bird abundance and bird diversity tend to be high in wind resource areas, which also tend to be in remote, less studied areas.

An earlier study in a different part of the Altamont Pass WRA involved 980 hours of bird surveys.[7] In that study the number of hours required per observation was 490 for Cooper's hawk, 980 for white-tailed kite, 163 for rough-legged hawk, 7 for loggerhead shrike (a commonly killed species), 43 for cliff swallow (another commonly killed species), and 2 for golden eagle. In the Altamont Pass, even though we invested more than 11 times the hours committed to Whistling Ridge, and even though we used scientifically accepted methods resulting in publication in peer-reviewed outlets, we were still unable to detect any significant relationships between fatality rates and utilization rates among rows or larger plots of wind turbines.[8] My colleagues and I concluded that not only were relatively small sample sizes an impediment to detecting a spatial relationship between fatality rates and utilization rates, but there was the interference of a substantial bias caused by declining survey detection rates with increasing distance from the observer, especially for smaller-bodied bird species. The survey effort at Whistling Ridge was grossly insufficient for informing decision-makers about the impacts of the project that will be caused by collisions of birds with wind turbines.

Q: Greg Johnson states in his testimony (Exhibit No. 6.00), "Due to the different years surveyed [fall 2004, summer 2006, winter 2008/2009, spring 2009], the [utilization] surveys have the added value of accounting for some hypothetical variation between different years." Do you agree that cobbling together seasons from different years adds value to the study's representation of inter-annual variation in utilization rates?

A: No. Before elaborating, however, I must point that there is nothing "hypothetical" about variation in relative abundance of birds between years. Returning to the question, a mean utilization rate for a given species observed in fall could vary inter-annually in a very different manner than a rate observed in summer, spring, or winter. Take Figure 2, for example, which depicts different inter-annual trends in seasonal utilization rates of red-tailed hawk at Diablo Winds Energy Project in the Altamont Pass. Which year should be picked to represent winter-time red-tailed hawk utilization of the Diablo Winds project area? If the year 2006 is selected, then the utilization rate that winter was nearly 20 times greater than the rate observed in winter 2007. If the investigator happened to pick years when fatality rates were lowest per season, i.e., the lowest fall rate, the lowest winter rate,

the lowest spring rate, and the lowest summer rate, then the annual fatality rate would be 18% of the annual fatality rate based on selection of the peak seasonal rates (Figure 3). More representative inter-annual variation in fatality rates is depicted by the black line in Figure 3. It is scientifically inappropriate to pool together seasons from different years to represent an annual utilization rate. It is also inconsistent with the full year of surveys recommended in the WDFW Guidelines and U.S. Fish and Wildlife Service Wind Turbine Advisory Committee Recommendations to the Secretary of the Interior.

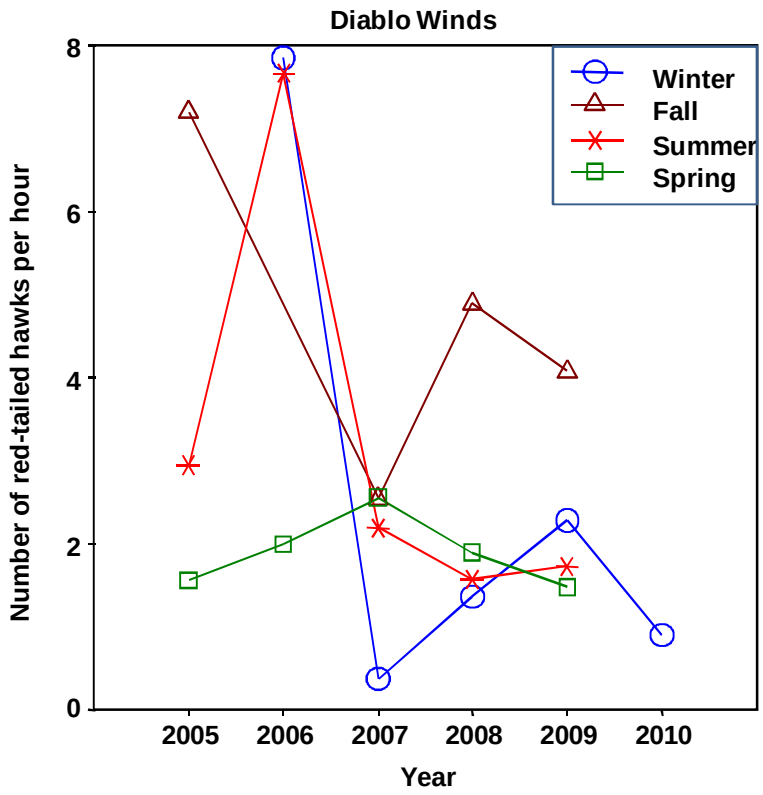

Figure 2. *Inter-annual variation in seasonal utilization rates observed at Diablo Winds Energy Project in the Altamont Pass, Alameda County, California.*

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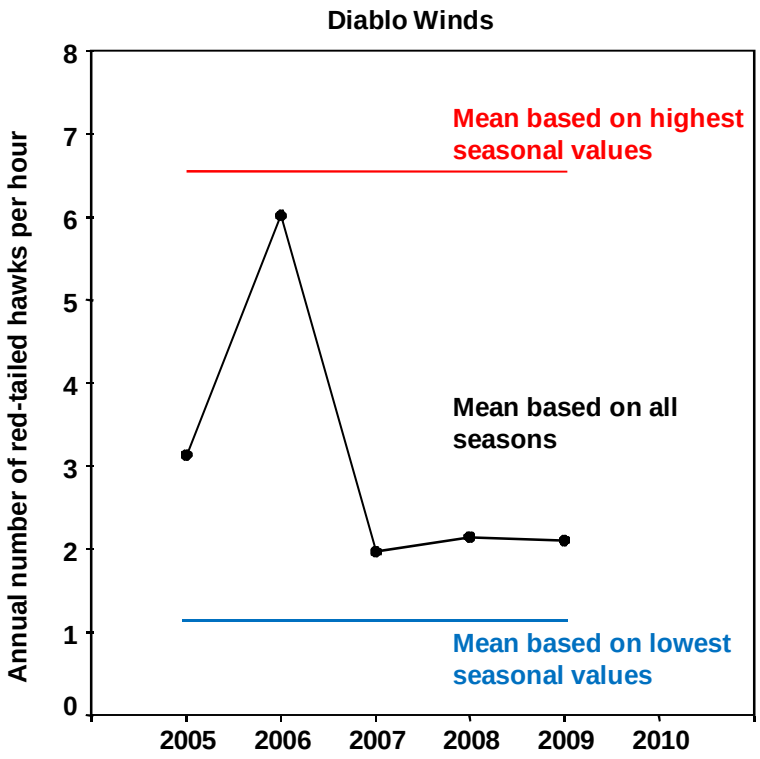

Figure 3. *Mean annual utilization rate of red-tailed hawks (black line) and annual rates based on lowest mean values per season (blue line) and highest mean values per season (red line). The annual utilization rate based on high values per season was 5.7 times greater than the annual utilization rate based on low values per season.*

Q: Do you have any concerns about the times of day when the surveys were or were not conducted?

A: Yes. The utilization surveys at Whistling Ridge were diurnal. Thus, the surveys did not record any birds flying at dawn, dusk, or at night, so they inadequately characterized the suite of bird species that uses the project area. (Utilization surveys are different from protocol-level call-back surveys used to detect northern spotted owls, and the data are recorded differently and used differently, including for wind turbine siting.) No nocturnal owl species would have been detected unless an owl flushed in daylight hours for some reason, and multiple other species would have been missed if they flew at night. This shortfall can be applied to most survey efforts that have been performed at wind project sites throughout the U.S., so it was not unique to Whistling Ridge. This shortfall should be acknowledged and the level of uncertainty attributed to conclusions of impacts should be increased.

Q: Could factors at the Project site interfere with or complicate visibility of the surveyed airspace?

A: Survey observation stations are typically located on prominent aspects of the study area so that the observers can scan for birds in as much of the airspace as possible. The surveyed airspace is that airspace between the observer and the maximum survey radius (a maximum distance from the observer), and between the ground and to whatever elevation above the ground (ceiling) the surveyor is scanning for birds. WEST, Inc. routinely uses an 800-m maximum survey radius. However, at least some of the airspace between the observer and the maximum survey radius is usually hidden from the observer, due to hills, the slope of the hill upon which the observer stands, trees, and the prevalence of fog or clouds. In hilly or mountainous terrain, observers stationed on prominent locations might be able to see a smaller proportion of the available airspace between 40 and 100 m away due to the slope dropping away from the observer. These observers might be able to survey a larger volume of airspace between 100 and 250 m away because those distances overlap canyon bottoms into which the observer might be able to see and over which there is more airspace due to a larger elevation range extending from below the observer (canyon bottom) to whatever elevation ceiling the observations might extend (assuming there is a ceiling). In other words, prominent locations tend to provide surveyors with variable volumes and proportions of volumes of airspace as functions of distance from the observer, due to the manner in which the ground surface slopes away from the observation station.

The ground surface area of a flat circle within 800 m of the observer at a single station equals 2.01 km^2. Assuming the WEST, Inc. survey team can see birds as high as they seem to think they can see them in distance, the volume of airspace surveyed on perfectly flat and unobstructed landscapes would be 1.61 km^3, which in my opinion is a huge volume of airspace in which to expect to see more than a small fraction of the available birds In the Altamont Pass my colleagues and I did not believe we could reliably detect most birds flying as high as 800 m, so we selected a ceiling of 140 m above the elevation of the observer, excluding birds above that ceiling from utilization rate estimates. This 140-m ceiling above flat terrain would have the surveyors searching 0.28 km^3, which is still a volume I consider unmanageable, but which is much smaller than within an 800-m ceiling.

However, flat ground is rarely where bird surveys are performed in WRAs, especially in the Pacific Northwest. From station to station, and from project site to project site across the U.S., the visible volume of airspace surveyed will vary greatly due to variability in topography and forest cover surrounding each station. To illustrate the influence of this variability, Lee Neher and I constructed a digital elevation model (DEM) of the Vasco Caves Regional Preserve in the Altamont Pass and we calculated the volume of airspace visible from each of 15 observation stations (Figure 4). Our results demonstrated that bird

observations need to be related to visible volumes of airspace to avoid confounding any comparison that would be made of utilization rates among observation stations or wind project sites.

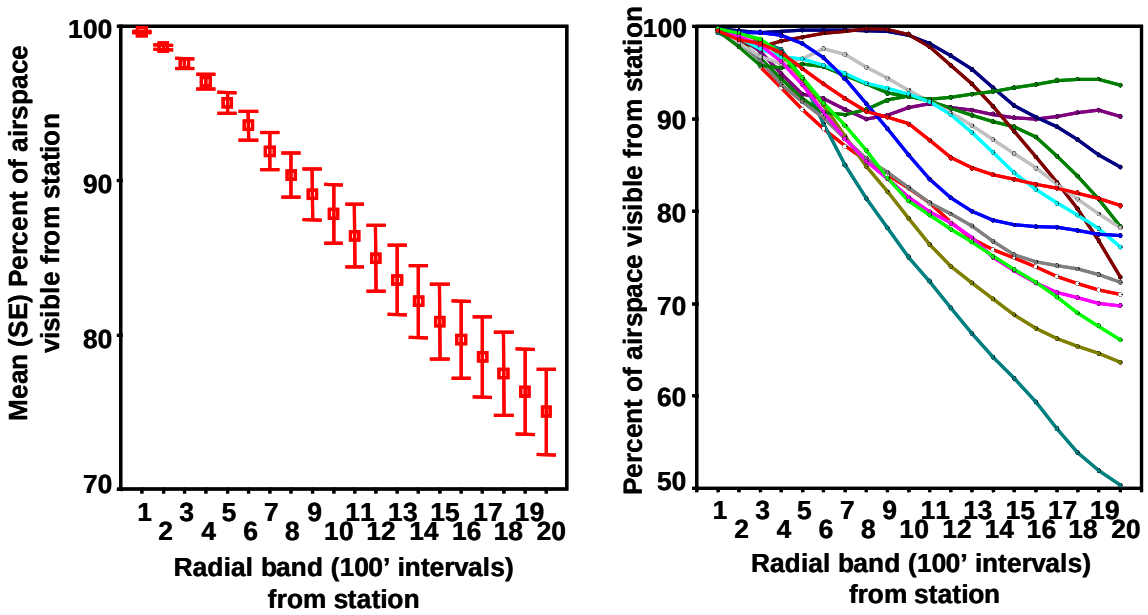

Figure 4. *Change in mean (left graph) and station-specific (right graph) percentage of visible volume of airspace within 140-m ceiling and within specific radial bands from the observer (x-axis) among 15 observation stations at Vasco Caves Regional Preserve in the Altamont Pass. Note that our maximum survey radius was 2009 feet, or 600 m, whereas WEST, Inc. uses a maximum survey radius of 800 m, including at Whistling Ridge. Projecting the trends in this Figure to 800 m, we might expect a mean of 60% of the airspace to be visible, ranging about 20% to 94% among the stations, and this variation did not include airspace hidden by forest surrounding observation stations at Whistling Ridge. Without accounting for this source of variation in utilization rates, comparing utilization among sites within a project area could be misleading, and comparing utilization rates among wind project sites across the U.S. might qualify as very misleading.*

Lee Neher and I quantified the effect of variable distances of birds from the observer, using our DEM of a project area in the Altamont Pass (Figures 5 and 6). We calculated detection functions from the patterns depicted in Figures 5 and 6 (see Table 2), which allowed the projection of our detection rates to visible volumes of airspace within the maximum survey radii used by other investigators. Raptor utilization rates within an 800 m maximum survey radius would be reported at about 134% of the rate within a 600 m maximum survey radius, at 204% of the rate within a 400 m survey radius, and 927% of

the rate within a 100 m survey radius. Without accounting for the effect of distance from the observer, utilization rates cannot be compared among wind projects, nor can utilization rates be compared appropriately among species.

		Model parameters				
Species/Group	**Model**	**a**	**b**	**r^2**	**SE**	**P**
Golden eagle	Power	12.6915	-0.7430	0.97	0.10	0.001
Red-tailed hawk	Power	90.0736	-0.6041	0.96	0.10	0.001
Turkey vulture	Power	66.4367	-0.7159	0.97	0.11	0.001
Northern harrier	Logarithmic	11.0526	-3.2695	0.95	0.63	0.001
Prairie falcon	Power	21.8581	-1.1817	0.98	0.14	0.001
American kestrel	Power	75.5038	-1.0143	0.94	0.21	0.001
Raptors	Power	281.1493	-0.7349	0.97	0.10	0.001
Common raven	Power	306.0222	-0.7777	0.97	0.12	0.001

Table 2. *First detections/hr/km^3 of visible airspace regressed on distance from observer within radial boundary increased from 30 m to 600 m at Vasco Caves Regional Preserve, California.*

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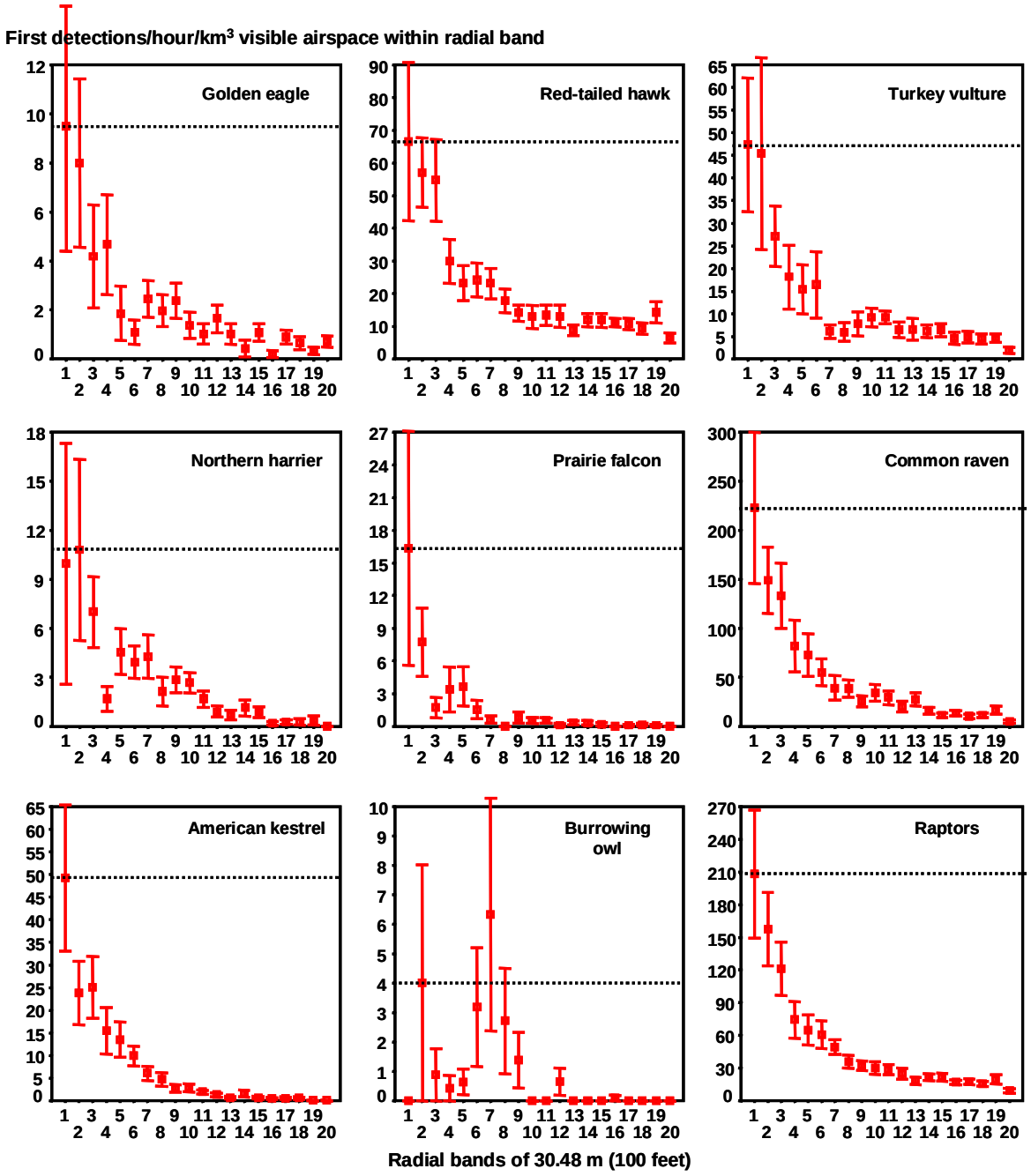

Figure 5. *Within specific 100-foot radial bands, mean first detections/hour/km³ of visible airspace decreased with increasing distance from the observer for golden eagle, red-tailed hawk, turkey vulture, northern harrier, prairie falcon, common raven, American kestrel, burrowing owl, and all raptors as a group in Vasco Caves Regional Preserve, 2006-2007. Horizontal dashed lines represented detection rates expected of each species assuming spatial distributions were most accurate within the closest 100 or 200 feet to the observer.*

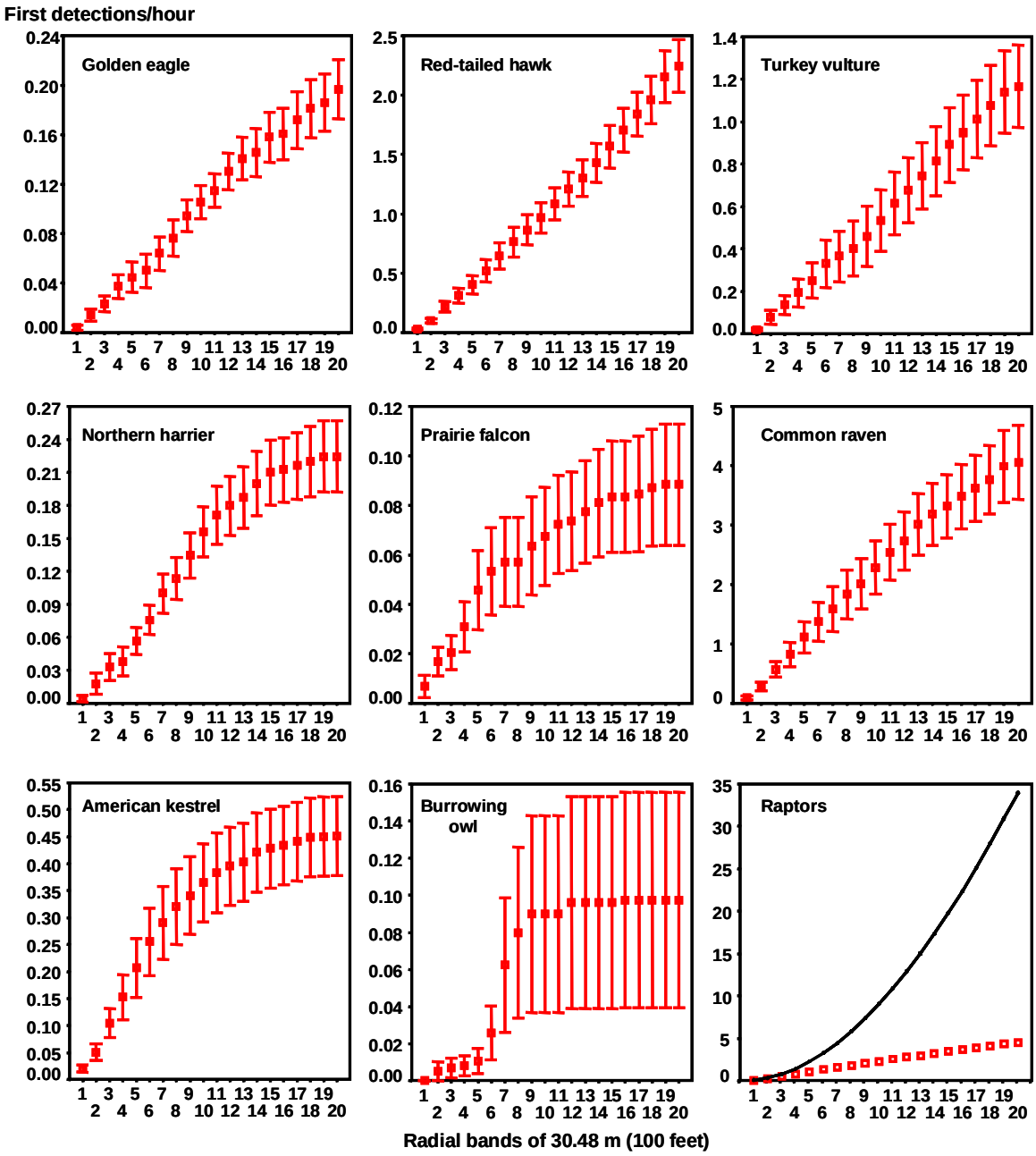

Figure 6. *Cumulative mean first detections/hour increased with increasing distance from the observer for golden eagle, red-tailed hawk, turkey vulture, northern harrier, prairie falcon, common raven, American kestrel, burrowing owl, and all raptors as a group in Vasco Caves Regional Preserve, 2006-2007. The solid line in the lower right graph depicts the exponential increase in cumulative detections of raptors, assuming the spatial distribution of raptors was unaffected by the locations of observation stations and detection rate was most accurate within the closest 100 feet.*

Q: Have you reviewed predicted fatality rates for wind power projects for their accuracy?

Yes. I have used data available in reports to independently estimate fatality rates at project sites across the western U.S. My estimates averaged 2.44 times higher than reported for all birds as a group (N = 23 reports), 1.34 times higher for all raptors as a group (N = 23), and 2 times higher for all bats (N = 20). One reason for my higher estimates was the difference in fatality estimator. Most of the monitoring reports I reviewed had utilized the following estimator of fatalities per MW per year, F_A:

$$F_A = \frac{F_U}{\left(\frac{\bar{t} \times p}{I}\right) \cdot \left(\frac{e^{I/\bar{t}} - 1}{e^{I/\bar{t}} - 1 + p}\right)}, \qquad \text{eqn. 1}$$

where F_U is unadjusted average number of carcasses observed per MW per year, $\bar{t}$ is mean number of days until carcass removal, and is estimated by scavenger removal trials, p is proportion of carcasses found by fatality searchers during searcher detection trials, and I is average search interval in days. The other estimator in use, and the one I use, is derived from the Horvitz and Thompson (1952)[9] estimator:

$$F_A = \frac{F_U}{R_C \times p}, \qquad \text{eqn. 2}$$

where R_C is the average proportion of carcasses remaining since the last fatality search and is estimated by scavenger removal trials. I assume carcasses are deposited at a steady rate from wind turbines, so I take the average proportion of carcasses remaining each sequential day between searches:

$$R_C = \frac{\sum_{i=1}^{I} R_i}{I}, \qquad \text{eqn. 3}$$

where R_i is proportion of carcasses remaining by the ith day following the initiation of a scavenger removal trial. Thus, the expected proportion of carcasses remaining by the next fatality search should be R_C corresponding with the fatality search interval, I.

A key difference between the two estimators is the use of $\bar{t}$ in eqn. 1 and the use of R_C in eqn. 2. The sample size of placed carcasses contributing to R_C never changes from start to finish of a removal trial, as none of the carcasses need to be censored. On the other hand, the sample size contributing to $\bar{t}$ starts small and increases quickly as the trial grows longer (Figure 7, left graph). If 10 carcasses were placed to obtain R_C, then 10 carcasses will contribute to R_C after 1 day, 10 days, or 30 days. If 10 carcasses are placed to obtain $\bar{t}$, then it may be that none of them will contribute to $\bar{t}$ after a day because none had been removed by then, and so all had to be censored from the calculation. If 4 carcasses were

removed after 10 days, then only these 4 would contribute to the calculation of $\bar{t}$. If 7 carcasses were removed after 30 days, then only these 7 would contribute to the calculation of $\bar{t}$. Thus, $\bar{t}$ increases exponentially with the sample size used to calculate $\bar{t}$ because the increasingly large sample is also composed of carcasses that have persisted longer into the trial (Figure 7, right graph). Furthermore, $\bar{t}$ increases nonlinearly with number of days into a trial (Figure 8), indicating a bias. Perhaps the main bias, however, is the use of $\bar{t}$, which is derived from a time period that is necessarily much longer than the average search interval of the fatality monitoring (see text that follows).

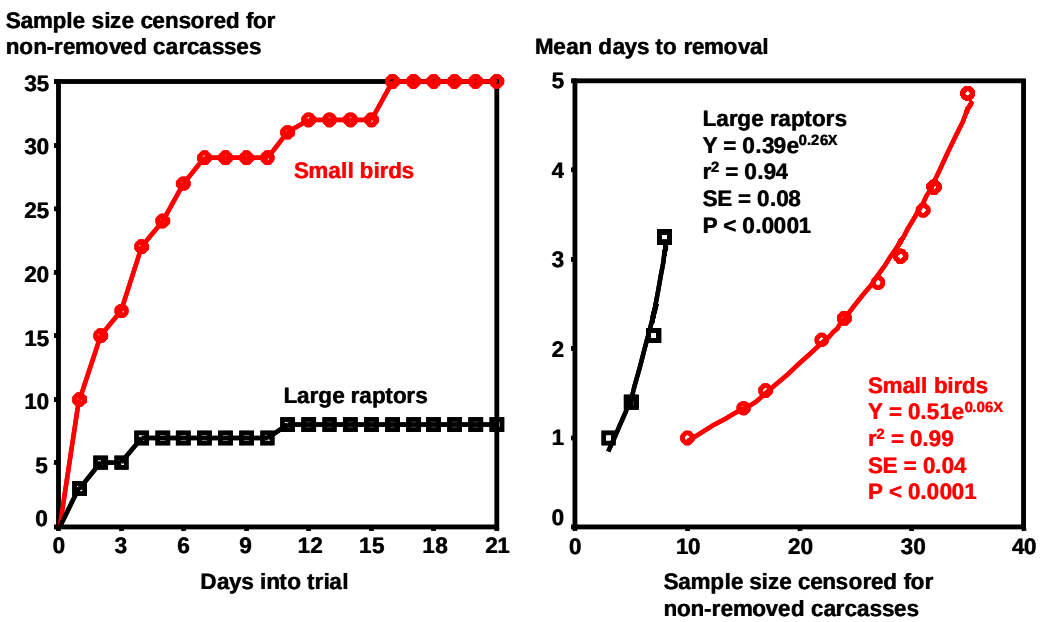

Figure 7. *Sample sizes used to calculate mean days to carcass removal decline with shorter trial duration (left graph), and mean days to removal increases exponentially with sample size (right graph) at Vasco Caves Regional Preserve, Altamont Pass, California.*

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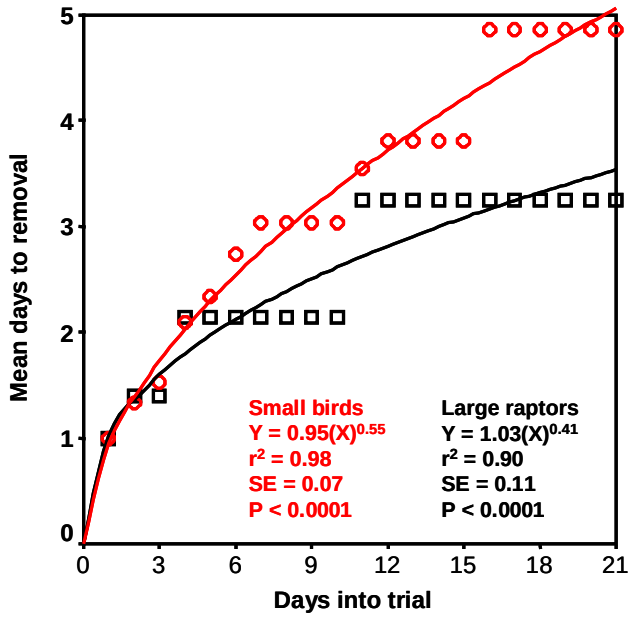

Figure 8. *Mean days to carcass removal increases with longer duration of the carcass removal trial at Vasco Caves Regional Preserve, Altamont Pass, California.*

When censoring remaining carcasses, $\bar{t}$ cannot be calculated unless at least one carcass has been removed. If no carcasses are removed during a trial, then $\bar{t}$ will be undefined, whereas R_C would equal 1 and the fatality rate could still be estimated. To prevent a trial result in which no carcasses are removed, and hence $\bar{t}$ cannot be calculated, investigators can place larger numbers of carcasses or they can perform longer trials. Placing larger numbers of carcasses can potentially swamp the vertebrate scavengers, thereby increasing mean days to removal. The option to perform longer trials might help explain why many of the trials intended to obtain $\bar{t}$ have been conducted for 40 to 64 days, or from nearly twice as long to more than four times longer than the average search interval used in the corresponding fatality monitoring. Values of $\bar{t}$ derived from such long trials will be larger than those derived from trials lasting no longer than the fatality search interval (Figure 7), and the fatality rates will be underestimated.

I must also point out that my estimates, relying on eqn. 1, remain conservative because I have yet to account for declining searcher detection rates as the search interval increases (searcher detection trials are based on a search interval of less or equal to one day). I also have not accounted for crippling bias—the non-detection of mortally wounded birds that leave the search area on their own volition before perishing—because there is no means to account for this bias. Underestimates of fatality rates in the Pacific Northwest might be partly caused by reliance on mean days to carcass removal as an adjustment for scavenger

removal rates (Smallwood 2007), but some of the scavenger removal trials were sufficiently flawed that I had to replace their results with national averages in Smallwood (2007). Under-estimated fatality rates have been used to predict fatality rates of planned projects, which may be one reason why predicted fatality rates have so often been wrong (Table 1).

Q: How does your research on the accuracy of predicted fatality rates reflect on the regression analyses for the Whistling Ridge Project? Are the regression analyses for the Project credible?

The regression analyses appearing in *Figure 5* of App. B-6 of the Application and *Figure 8* of App. C-4 of the DEIS were based on inaccurate fatality rate estimates.

For example, the data presented in these two figures were derived mostly from one-year monitoring programs. However, inter-annual variation in fatality rates and utilization rates can be very high at a given project site. For example, fatality rates varied 5.7-fold from low to high over 8 years within a 10-year period in the Altamont Pass WRA (Figure 9). They varied nearly 2-fold over a 3-year period at Foote Creek Rim[10] and nearly 3-fold over a 4-year period at Buffalo Ridge.[11] Given this range of variation, single-year estimates are mere snapshots of fatality rates and unlikely to reveal meaningful relationships between fatality rates and utilization rates among wind projects.

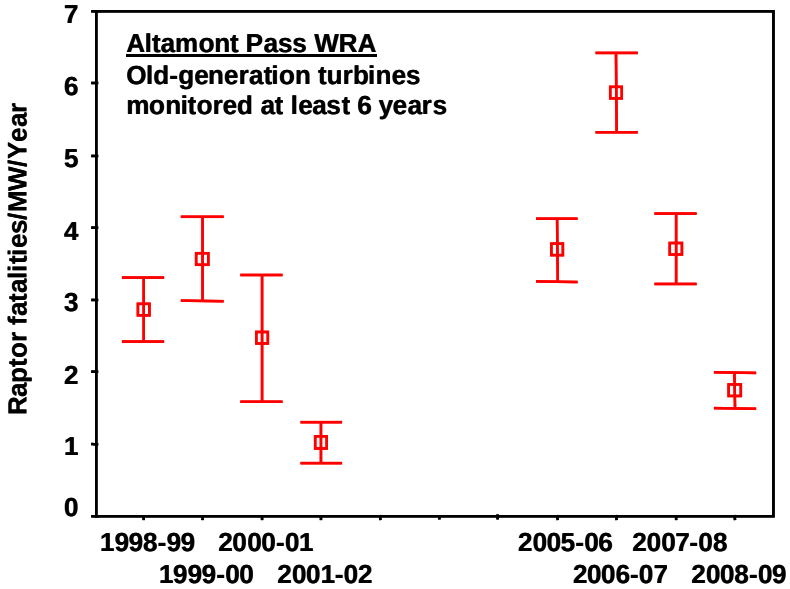

Figure 9. *Inter-annual estimates of raptor fatality rates in the Altamont Pass WRA.*

Furthermore, *Figure 5* of App. B-6 of the Application and *Figure 8* of App. C-4 of the DEIS were based on only some of the wind projects for which there exists fatality rate and utilization rate estimates. When more of the available estimates are included, the regression slope reported by Johnson et al. in the Whistling Ridge DEIS no longer applies (Figure 10).

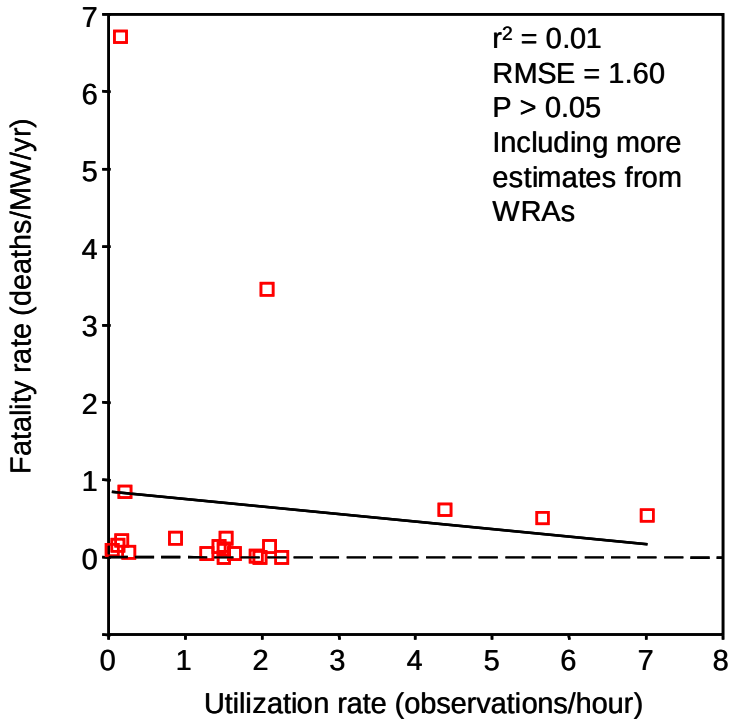

Figure 10. *Fatality rate estimates regressed on utilization rate estimates after including data from additional WRAs to those used by WEST, Inc.*

WEST, Inc. has been inconsistent in its utilization rates and fatality rates used to construct its regression models for this Project. For example, in the environmental review documents prepared for Windy Point, Windy Flats, and Hatchet Ridge, data representing the two extreme California wind projects (Diablo Winds and High Winds) indicated 30% higher utilization rates than depicted in the Whistling Ridge DEIS. Also, the fatality rate representing Diablo Winds was half as great in the Windy Point, Windy Flats, and Hatchet Ridge documents compared to the Whistling Ridge DEIS. Compared to the regression model presented in the environmental review documents for Windy Point, Windy Flats, and Hatchet Ridge, the regression slope was more than twice as steep in the model presented for Whistling Ridge.

The DEIS (page 3-79) predicted that Whistling Ridge will cause 0 raptor fatalities because its estimated utilization rate appeared to the left of the Y-axis 0-intercept in *Figure 8* of

App. C-4. This prediction was unrealistic and inconsistent with the very data that contributed to the estimated regression line. In fact, one of the wind projects that contributed to Johnson et al.'s regression model also appeared to the left of the Y-axis 0-intercept, but it was represented as having killed 0.09 raptors/MW/year (my estimate of the fatality rate of this project was twice as high, however). In addition to this inconsistency in the use of the regression, omitting the two Central California wind projects from the analysis flips the regression slope from positive to negative, potentially leading to an opposite conclusion – that Whistling Ridge will kill more raptors than any other wind project in Washington or Oregon. However, for multiple reasons discussed below, I advise against using my revised regression line or the Johnson et al.'s regression line for predicting fatality rates.

Utilization rates contributing to the regression model were often calculated as means among seasonal totals, rather than annual total observations per year or weighted averages. Weighted averages should be used if surveys were performed regularly across all seasons, where the weightings are based on duration of each season. Without weighting, simple averaging among seasonal utilization rates likely under-represents the contributions of longer seasons with higher bird use.

The Applicant's consultants have been unable to accurately predict raptor fatality rates, as demonstrated above. In fact, their predictions have been much too low, and the same problem can be demonstrated for bats and other bird species. Upon examination, the methods used to predict fatality rates appear to be ineffective, as raptor fatality rates failed to correlate with nesting densities, utilization rates, and exposure index values (see below). The methods used by the consultants simply do not work. Their predictions of fatality rates cannot be relied upon.

Q: The Applicant used an exposure index to predict fatality rates. Is this a reliable basis for predicting fatality rates?

A: On page 3-77, the DEIS summarizes the calculation of the exposure index (also see App. C-4), which it said was used to assess the risk of collision of each bird species. In fact, on the same page and on subsequent pages the DEIS did just that – it offered conclusions about the likelihoods of collision-caused fatalities based on values of the exposure index. The Application includes similar analyses and conclusions at page 3.4-30, page 4 of App. B-5, and page 4 of App. B-6. However, I have never seen a test of the relationship between fatality rates and exposure index. Based on my own experience attempting to relate fatality rates to variables similar to the exposure index, I am skeptical that WEST, Inc. has actually generated a result from a hypothesis test that would support the use of the exposure index as a predictive tool. Therefore, I tested for a relationship using data from the Big Horn and Wild Horse Wind Projects (Figure 11).

I found no hint that fatality rates could be predicted by the exposure index. Furthermore, between the two projects 27 species (23%) were not detected during utilization surveys at one or both project sites but were killed by wind turbines at the same project site. Of the 22 species that were detected during utilization surveys at one or both project sites and that were also killed by wind turbines, only 4 of them (18%) were given exposure index values >0. In other words, there was no correspondence between the exposure index and fatality rates. The exposure index appears to be completely ineffective as a predictor of fatality rates caused by wind projects.

Q. Are raptor nesting densities a reliable predictor of fatality rates caused by wind projects?

A: I collected reports of raptor nesting densities and raptor fatality rates from wind projects throughout the western states. I found no trend in the relationship between fatality rates and nesting density that would suggest that nesting density explains some of the variation in raptor fatality rates (Figure 12).

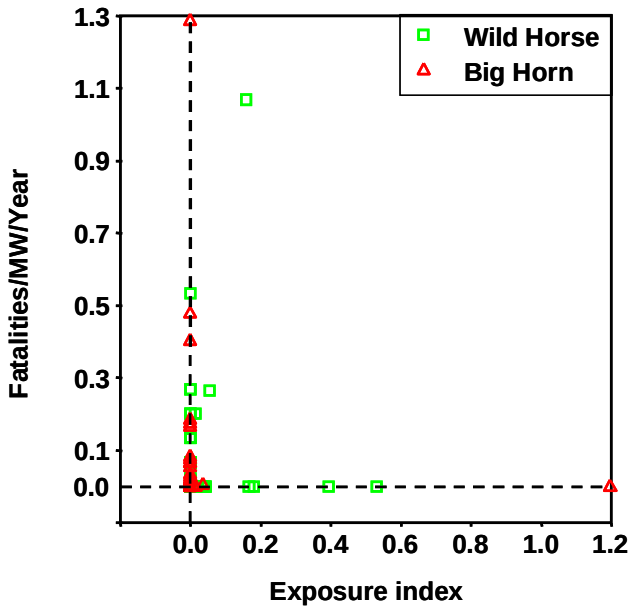

Figure 11. *Relationship between fatality rates and exposure index values for each bird species documented in utilization surveys and fatality searches at the Big Horn and Wild Horse Wind Energy projects. I omitted bats and unidentified birds such as sparrow, falcon, or passerine. I included only estimates for individual, named species, totaling 115 estimates between the project sites (some species appear twice, once for each project site).*

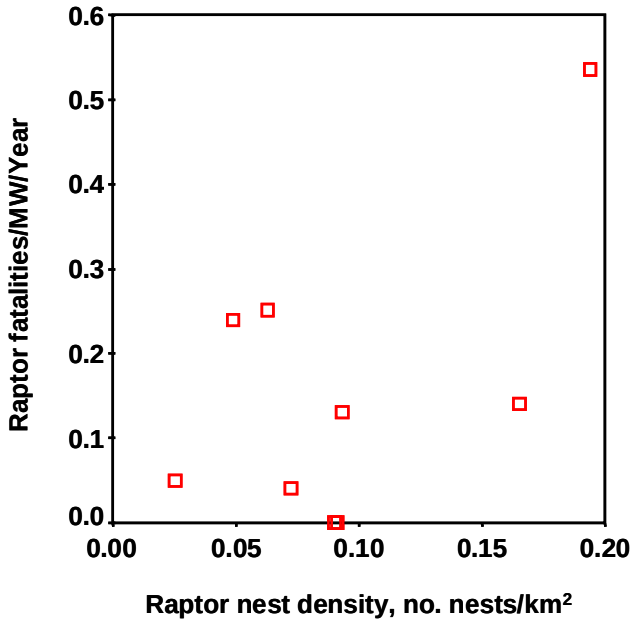

Figure 12. *Raptor fatality rates did not correlate significantly with raptor nest densities recorded on project sites and usually within a 2 mile buffer of the project boundaries. Raptor nesting density did not appear to predict raptor fatality rates at wind projects.*

Q: The Application on page 7 of App. B-5 states that raptor mortality is "expected to be low." Similarly, the DEIS predicts that 0 raptors would be killed by the Project. Do these conclusions comport with the record of fatalities documented at existing wind energy projects?

A: No. There have been only two wind projects that documented 0 raptor fatalities, but those estimates were based on one year of fatality monitoring, which was insufficient. Based on reports of fatality monitoring at 28 wind projects in Washington, Oregon and California, the average fatality rates projected to 75 MW of rated capacity would predict 30 raptor fatalities per year, 406 bird (including raptor) fatalities per year, and 95 bat fatalities per year (Table 3). However, the Whistling Ridge project site differs from all the others because it would be in a mountainous and forested environment that is also often enveloped by clouds. Given the absence of existing wind farms in these conditions in the Pacific Northwest, I cannot provide reliable estimates of collision rates at Whistling Ridge, but I caution that fatality rates could be much higher than listed in Table 3.

Furthermore, the fatality rate projections in Table 3 are interim rates before I update Smallwood (2007) to improve the adjustment factors for searcher detection error and scavenger removal rate. My 2007 paper was based on available searcher detection and

scavenger removal trials available at the time, but hundreds of trials have been performed since then. I have integrated the data from these hundreds of trials, and I have observed much faster removal rates for most taxonomic groups, especially for bats, as well as lower searcher detection rates. I have not had time yet to finalize my analysis of these data from newer trials. I anticipate that my fatality rate estimates will be higher once I have updated Smallwood (2007).

	Collision deaths/MW/yr		Annual deaths
Group	Predicted in Whistling Ridge DEIS	Mean among 28 modern wind projects in western U.S.	Projected to Whistling Ridge (80% CI)
All raptors	0	0.40	30 (3-34)
All birds	No prediction	5.42	406 (54-519)
All bats	"Some"	1.27	95 (35-213)

Table 3. *Predicted wind turbine-caused annual fatalities based on projections of my independent estimates of collision deaths/MW/year among 28 modern wind farms in Washington, Oregon, and California. Note that these projections did not account for the unique environmental setting of Whistling Ridge, as none of the available fatality rate data were from forested landscapes. Fatality rates could be considerably higher at Whistling Ridge due to forest cover and due to occlusion of turbines caused by the area being frequently enveloped by clouds.*

Q: The Application states at page I-2 that "the project site is heavily developed, includes no native habitat, and is permanently committed to its use as a utility corridor." Similarly, the DEIS states at page 3-35 that "the project area includes no native habitat and is permanently committed to use by commercial forestry operations" and, due to frequent and repeated disturbances, "the quality and value of the forest is generally considered low." Could you please evaluate these statements?

A: These statements reveal a lack of understanding in the habitat concept, and are therefore inappropriate in a document intended to inform the public and decision-makers. Habitat is defined by the species' use of the environment,[12] so there is no such thing as "native habitat." The fact that many terrestrial vertebrate species continue to reside and use the project area, as documented by the utilization surveys,[13] is proof that the project site continues to serve as habitat for many species. Over 87 hours of surveys from fixed observation stations, WEST, Inc. detected 90 species of bird, which equals >1 species per hour detected. For comparison, 979 hours of survey at Altamont Pass detected 35 bird species, or 0.036 species per hour.[14] Bird species diversity is much greater at Whistling Ridge than at the Altamont Pass, where bird fatalities caused by wind turbines are notoriously high. An appropriate habitat assessment would likely have raised a red flag

because habitat at Whistling Ridge is obviously suitable for a great variety of bird species, many of which will be susceptible to collisions with wind turbines.

Despite past timber harvest, the project site and its surroundings exhibits a high degree of ecological integrity. Ecological integrity is the degree to which the species assemblage is composed of native species that are supposed to occur in a particular environment.[15] The degree to which a species list is composed of exotic species is a measure of site invasibility (*i.e.*, the degree to which a site has been invaded by exotic species), which tends to increase with reduced ecological integrity.[16] Of the 90 bird species detected at Whistling Ridge, only wild turkey was exotic, and this species is quasi-exotic as it only spread its range from east of the Mississippi River. Contrary to the misleading characterization in the Application and DEIS of poor habitat and low value, Whistling Ridge exhibits a very high level of ecological integrity and a very low level of site invasibility for terrestrial vertebrates. To be consistent with the WDFW Wind Power Guideline's recommendation (§ 5.1) that wind project developers should be discouraged from using or degrading high value habitat areas, the proposed Whistling Ridge project site is inappropriate.

Q: The project site is located within the designated Columbia Gorge Spotted Owl Special Emphasis Area. Could you please evaluate the analysis and conclusions in the DEIS about whether northern spotted owls may be taken by the Project?

A: The DEIS concludes at page 3-50 that "northern spotted owls will not be 'taken' by the proposed project." I disagree with the foundation for this conclusion. The argument was made that a U.S. Fish and Wildlife Service protocol can be interpreted to conclude that northern spotted owls no longer occupy historical nest sites because owls were not detected at the sites in 6 to 8 years. Government protocols do not dictate biological reality. It has been well established that animal populations tend to be spatially dynamic, meaning that centers of activity shift periodically.[17] In most cases, the shifting of activity centers tend to shift locations every generation or so, and I would consider 6 to 8 years to be close to the time span of a northern spotted owl generation. Hypotheses for the spatial shifts have included: (1) escaping parasite or predator loads; (2) exhaustion of resources; (3) dispersal of progeny as the natal population senesces; and, (4) some combination of these hypothesized factors. Just because a species has not been detected for a while does not mean the species will never return, and I state this without implying that I believe northern spotted owls no longer occur at the site.

In fact, northern spotted owls do occur near the project site, according to recent surveys reported by Reams (Exhibit No. 5.00, page 8, line 7). Given that the project area supports northern spotted owl habitat and given that at least one owl was observed nearby very recently, some consideration should be given to the possible attraction of northern spotted owls to carrion produced by wind turbines. In the Altamont Pass, use of remotely

triggered infra-red cameras revealed the removal of a great-horned owl carcass by another great-horned owl under wind turbines (Smallwood et al. 2008). If northern spotted owls feed on carrion, as great-horned owls are now known to do, then northern spotted owls could be attracted to forage around wind turbines because the turbines will regularly provide food. As recognized by the WDFW Wind Power Guidelines (§ 2.1), the availability of carrion is generally known to increase avian impacts with wind turbines.

Q: Could you briefly describe the potential direct impacts of wind energy projects on bats?

A: Impacts to bats are of growing concern to conservationists and ecologists, because in some places the fatality rates of bats have far exceeded those of birds in the Altamont Pass. A recent study using thermal imaging found that bats forage around moving turbine blades.[18] These bats were not just flying through the rotor plane, but actually chasing insects around the moving blades. More recently yet, Baerwald et al. (2008) found that most bats died of lung hemorrhaging due to the sudden drop in pressure behind the rotor plane through a process known as barotrauma.[19] In other words, bats usually do not even need to collide with the turbine blades to be killed by the wind turbines. Although the Application and DEIS cite Baerwald (2008) for other reasons, the possibility of barotrauma impacts to bats is not acknowledged in the Application nor in the DEIS.

Q: On page 3-59, the DEIS states, "little is known about this species [Keen's myotis]," and then a few sentences later it states, "the likelihood of occurrence on the site is considered low." Similarly, on page 3-60, the DEIS states, "Based on lack of detailed information on this species [Townsend's big-eared bat] distribution and nature of the bat surveys conducted on the site, it is difficult to conclude with certainty the likelihood of Townsend's big-eared bats occurring on the project site. … the likelihood of occurrence on the site is considered to be low." Could you please evaluate these statements?

A: These conclusions are inconsistent with the foundation statements. In both these cases, the conclusions of low likelihood of occurrence came immediately following admissions that the analysts knew very little about these species. These types of conclusions are inconsistent with the precautionary principle in risk assessment, which should be a principle applied to any environmental analysis.

Q: Can wind energy projects displace wildlife?

A: Yes. In addition to wind turbine collisions, wind turbines also displace multiple bird species, which have demonstrated aversion to the presence of wind turbines.[20] Some raptor species have demonstrated high turbine avoidance behaviors at wind farms,

including an estimated 100% avoidance by northern harriers at 6 sites in the U.S., 99.8% at one site, and 93.2% at another site.[21] Kerlinger et al. (2005)[22] compared post-construction bird activity to pre-construction activity in the High Winds Wind Project area in Solano County, California. They reported substantial reductions in bird use of the project site for numerous species. Compared to pre-construction activity levels, post-construction activity declined 75% for golden eagle and horned lark, 82% for American crow, 91% for cliff swallow, 81% for house finch, 33% for killdeer, 55% for northern mockingbird, 100% for rough-legged hawk, Say's phoebe, long-billed curlew, chipping sparrow, song sparrow, white-crowned sparrow, scrub jay, and tricolored blackbird, as well as for other species. These levels of apparent avoidance of the project site due to the installation of wind turbines represent reductions of habitat suitability, and ultimately habitat loss for these species.

Q: Could you please evaluate the potential population impacts of this Project?

A: On page 3-83, the DEIS states, "The proposed project would cause mortality to birds and bats through turbine collisions. However, the level of mortality is not anticipated to be sufficient to negatively affect the population viability of any single species." This conclusion was offered in the absence of any population viability analyses (PVAs) or any other defensible risk assessments or any method that could be considered as standard protocol. There is no scientific basis for this conclusion. In the discussion that follows, I address the cumulative impacts analyses performed by WEST, Inc. and included in the DEIS as Appendices C-11 and C-12.

In Apps. C-11 and C-12 of the DEIS, Johnson and Erickson (2008)[23] and Young and Poulton (2007)[24] performed what they termed cumulative effects analysis. In the case of Johnson and Erickson (2008), the cumulative effects analysis was of the wind industry's desired build-out of about 6,700 MW of wind energy capacity on the Columbia Plateau spanning eastern Washington and eastern Oregon. They averaged fatality rates from existing wind farms in the region and multiplied the average rate against the desired build-out capacity of 6,700 MW. They then compared their predicted annual fatalities to their estimates of regional population size, relying on a population estimator based on breeding bird survey (BBS) results from the 1990s and provided by the Partners in Flight North American Landbird Conservation Plan. However, these estimates were unsuitable for the use that Johnson and Erickson (2010) and Young and Poulton (2007) made of them, and I found several other problems with the analysis, discussed below.

Johnson and Erickson (2010) neglected to mention that there exist relatively large standard errors associated with the mean detections per BBS route. I used the standard errors to calculate 95% confidence intervals, which yielded very large ranges of population size for each species addressed in Johnson and Erickson (2008). For example, the lower

bound estimate for ferruginous hawk was less than 0, and the differences between one side of the confidence interval and the mean population estimate ranged 29% (American kestrel) to 65% (ferruginous hawk) of the magnitude of the mean. Without addressing the large error terms in the data, Johnson and Erickson (2008) inadequately informed the reader about the suitability of their population estimates for assessing biological significance of "cumulative impacts."

More importantly, Johnson and Erickson (2008) dismissed strong criticism of the Partners in Flight approach. Thogmartin et al. (2006)[25] reviewed the population estimation approach of Partners in Flight, and found the approach to be an inappropriate use of BBS data. The BBS was designed for detecting long-term population trends, but not for estimating population size. Thogmartin et al. (2006) also pointed out several potential biases in the Partners in Flight use of BBS data. The most likely and most substantial bias is the extrapolation of detection rates from roadways across large expanses of potential habitat lacking roads. Having performed many years of bird surveys both along roadways and far from roads, I cannot agree more with Thogmartin et al.'s conclusion that this was a serious bias, and one that likely inflated population estimates of the species addressed in Johnson and Erickson (2008). American kestrels, red-tailed hawks, and ferruginous hawks congregate along roadways because utility poles occur along roadways and are used for perching, especially on agricultural and shrub-steppe landscapes lacking natural tall perch structures. Furthermore, on agricultural landscapes, foraging habitat often occurs as strips between roads and disked fields. Extrapolating densities from roadways will produce absurdly inflated numerical estimates of numerous bird species, especially for American kestrels because their densities were estimates only within 200 m of BBS routes (the usual radius used by Partners in Flight was 400 m). A later version of Johnson and Erickson's cumulative impacts analysis (Johnson and Erickson 2010), which was mysteriously not the analysis used in App. C11, dismissed Thogmartin et al.'s review because no other regional population estimates exist for the Columbia Plateau. This rationale was unscientific.[26]

Johnson and Erickson (2008) did not provide a Partners in Flight estimate of the population size for golden eagles on the Columbia Plateau Ecoregion within Washington and Oregon because golden eagle fatalities had yet to be documented among wind turbines on the Columbia Plateau. However, golden eagle fatalities were subsequently documented, so the 2010 version of Johnson and Erickson's cumulative impacts analysis included a golden eagle population estimate, which was 1,700. For this number of golden eagles to occur on the Columbia Plateau within Washington and Oregon, the population density would have to be nearly as high as recorded in the Altamont Pass, or nearly one nesting pair per 19 km^2.[27] The Altamont Pass golden eagle density was characterized by Hunt et al.[28] as one of the highest ever recorded. Therefore, for the Johnson and Erickson estimate to be true, the Columbia Basin would require an Altamont-level density to extend across the entirety of the Plateau, which is highly unlikely based on my understanding of

animal density and distribution. Furthermore, the baseline studies performed by Johnson and Erickson and their WEST, Inc. colleagues have universally reported much lower golden eagle observations per hour among project sites in the Columbia Plateau Ecoregion as compared to the utilization rates documented in the Altamont Pass. As examples, WEST, Inc. reported 0 golden eagle observations during baseline surveys at Big Horn, 0.07/hour after 90 hours at Wild Horse, 0.033/hour after 270 hours at Golden Hills, 0.024/hour after 126 hours at Hopkins Ridge. For comparison, representative observation rates from the Altamont Pass have been 0.278/hour and 0.314/hour. The golden eagle population on the Columbia Plateau cannot be just as dense as in the Altamont Pass while at the same time trained observers count them at rates that are 0%, 8%, and 24% of the rates observed in the Altamont Pass.

As for Swainson's hawk, Johnson and Erickson (2008) estimated 10,000 breeding Swainson's hawks reside on the Columbia Plateau within Washington and Oregon. My model of nesting density projected only 579 pairs, or 1,158 adults.[29] My projection was extended beyond the study area sizes of all the population density estimates that were available to contribute to the model, so to be conservative I can rationalize doubling my estimate to 2,315, which is still a much smaller population size than estimated by Johnson and Erickson.

Johnson and Erickson estimated the breeding American kestrel population to be 170,000 on the Columbia Plateau within Washington and Oregon. This number would amount to 7% of the entire North American breeding population that was estimated 28 years ago, and it would be a much larger percentage of today's North American breeding population.[30] It would have me believe that at least 7% of North America's American kestrel population resides on 0.55% of North America's land mass, or nearly 13 times more densely other than expected in the Columbia Plateau Ecoregion. This regional population estimate also would have me believe there resides 1 breeding American kestrel for every 0.79 km^2, or one pair per 1.58 km^2. This density across such a large area would be highly unlikely. Furthermore, Johnson and Erickson (2008) claimed that the level of mortality likely to be caused by wind turbines following desired build-out in the Columbia Plateau would be sustainable and therefore of no significant population impact. This conclusion was not supported by a scientifically acceptable analysis, and it was inconsistent with the overall declining trend of American kestrels across North American and within Washington, specifically.[31]

Johnson and Erickson (2008, 2010) compared fatality rates among Oregon and Washington wind farms, and then extrapolated the mean fatality rates to the projected build-out of 6,700 MW of wind power capacity in the Columbia Plateau Ecoregion. The fatality rates in their Table 2 (Table 1 in the 2010 analysis) were too low (Table 4). For example, using the same data, I found their estimates to be low for Big Horn, Wild Horse, and Stateline. The raptor fatality rate reported for Big Horn was 0.15 deaths/MW/year,

whereas I estimated the rate to be 60% higher (see Exhibit 22.03).[32] The raptor fatality rate at Wild Horse was reported to be 0.09 deaths/MW/year, but I estimate the rate to be 178% higher. The raptor fatality rate at Stateline was reported to be 0.091 deaths/MW/year, but I estimated the rate to be 43% higher. Extrapolating my Wild Horse fatality rate estimates to 6,700 MW of cumulative capacity yielded 1,688 raptors per year and 27,230 total birds per year. Extrapolating my Big Horn fatality rate estimates to 6,700 MW of cumulative capacity yielded 1,625 raptors per year and 23,568 total birds per year. The average of the extrapolations from these two projects yielded 1,656 raptors per year and 25,399 total birds per year. These extrapolations are 3.2 times greater for all raptors and 1.4 times greater for all birds than forecast by Johnson and Erickson (2008, 2010), and I have yet to consider the confidence intervals around the fatality rate estimates, which are very large. As for American kestrel, Johnson and Erickson (2008, 2010) forecast 162 deaths/MW/year, but my average estimates between Wild Horse and Big Horn, extrapolated to 6,700 MW, indicates the cumulative toll will be 1,381 deaths/MW/year, or 8.5 times greater than forecast by Johnson and Erickson (2008, 2010).

I also compared cumulative annual fatalities predicted by WEST, Inc. (and included in the DEIS) to my predictions based on my independent estimates of fatality rates using data in the same reports (Table 4). Compared to the predictions made by WEST, Inc., my predicted cumulative annual fatalities caused by the projected build-out of wind energy facilities in the Columbia Basin Ecoregion were 6.3 times greater for raptors, 2.6 times greater for all birds as a group, and about the same for bats (Table 4). Most of the difference in predictions between those made by me and WEST, Inc. can be explained by the estimators used, and specifically whether scavenger removal rates of carcasses were characterized by mean days to removal or by proportion of carcasses remaining at the *i*th day into a removal trial (see earlier discussion).

	Annual deaths in 1,000 MW Klickitat County		Annual deaths in 6,700 MW Columbia Basin Ecoregion		My estimate as multiple of WEST, Inc. estimates	
Group	Predicted by WEST (2004)[33]	Projected by my mean estimate (N = 28)	Predicted by Johnson and Erickson (2008)	Projected by my mean estimate (N = 23)	Klickitat County	Columbia Basin Ecoregion
All raptors	33	400	469	2,680	12.1	5.7
All birds	1461	5,420	14,539	36,314	3.7	2.5
All bats	467-600	1,270	7,906	8,509	2.1-2.7	1.1

Table 4. *Differences in predicted fatality rates across neighboring Klickitat County and across the Columbia Basin Ecoregion, where the predictions were made by WEST, Inc. and by my use of the same data in available reports. Note that Whistling Ridge is not*

part of the Columbia Basin Ecoregion, but the DEIS nevertheless relied on a cumulative impacts analysis directed toward wind projects in the Columbia Basin Ecoregion. In either case, the WEST, Inc. estimates of fatality rates were much lower than my estimates, based on the same data.

In addition, it was inappropriate to compare avian use rates among wind farms without accounting for differences in maximum survey distances from the observer and in volumes of visible airspace from observation stations. Topography varies from place to place, and so does the proportion of the survey area that is visible from the observation stations. Also, detection rates of birds decline rapidly with distance from the observer, more so for smaller-bodied birds, so comparing use rates between wind farms will be substantially biased when the maximum survey distance was 800 meters in one wind farm and only 400 meters in another, or when few birds of one species will be detected beyond 300 m whereas most birds of another species will be detectable to 800 m. Without accounting for species-specific detection functions and variation in visible airspace due to topographic occlusion, comparisons of use rates cannot be reliable.[34]

Q: Have you researched and analyzed the relative impacts of wind energy projects when constructed at forested sites versus other settings? If so, can you tell us about your conclusions?

A: Yes. While developing a screening tool for siting wind energy facilities in California, I concluded that forested sites pose greater hazards to more bird species, including special-status species.[35] It appeared that overall impacts of wind power projects on wildlife would likely be greater in forested environments.

The Final Environmental Impact Statement for the Klickitat County Energy Overlay Zone (2008),[36] pertinent portions of which are attached to my testimony as Exhibit 22.02, reached similar conclusions. The Klickitat EIS concluded that (1) forest habitats tend to be more complex, have higher biodiversity, and lack ideal siting conditions for energy development (page G-18); (2) forested areas support higher concentrations of owls and other sensitive species than other areas (page 2-15); (3) use of forested areas by large falcons was significantly higher than in other cover types in the county (page 3-53); and (4) after screening of the alternatives, the FEIS recommended exclusion of large forest tracts from the geographic scope of the Overlay Zone due to the forest's support of more sensitive species (page 2-15, 3-68, and G-18).

Q: The Application at page 3.4-34 proposes to conduct two years of post-construction fatality monitoring. Do you concur with this proposal?

A: I concur with the need for post-construction monitoring, but the monitoring should be for both fatalities and utilization, because fatality rates need to be interpreted in context of utilization rates. Also, two years is an insufficient time period, given inter-annual variation in fatality rates and utilization rates. For fatality monitoring, I recommend that all turbines be searched for fatalities for at least three years following project installation and that a subset of the turbines be searched throughout the life of the project. The monitoring is needed to learn of successes and failures of the project planning so that the lessons can be applied to this and future wind energy projects. It is also needed to inform compensatory mitigation. All wind turbines should be included in the fatality monitoring to ensure adequate sample sizes are obtained. Fatality searches should be performed no less frequently than every two weeks, and two teams should perform searches independently of each other so that detection rates can be estimated without performing independent searcher detection and scavenger removal trials, which are fraught with biases and sources of uncertainty.[37] Utilization surveys should be weekly.

Q: The Application at page 3.4-34 and the DEIS at page 1.4-6 propose to convene a Technical Advisory Committee (TAC) for the project. Do you concur with this proposal, and do you have any recommendations regarding such a committee?

A: I agree that a TAC should be established, but EFSEC and BPA should impose minimum standards for TAC membership, including scientific credentials and experience with issues relevant to avian and bat impacts caused by wind projects. The TAC should be clearly authorized to select the fatality monitor, to require additional mitigation and/or recommend additional mitigation to EFSEC and BPA, and to change the monitoring.

Unless the TAC is formed long before project construction, I do not believe mention should be made of adaptive management. To be true adaptive management, the measures would need to be formulated ahead of time, along with thresholds of success and alternative prescriptions.[38] The TAC should work together with stakeholder groups to formulate an adaptive management plan, and the plan should be informed by adequate, directed pre-construction surveys. The currently available surveys are not adequate for informing adaptive management.

Q: The Application (page 3.4-34) and DEIS (page 1.4-6) state that several wind turbine design features would be employed as mitigation measures, including using tubular towers to minimize perching, minimizing lighting, and installing newer generation upwind turbines. Should these three design features be considered valuable mitigation measures?

A: These three design features do not in any way mitigate for the impacts to birds and bats through direct collisions and barotrauma. All three of these design features are pursued for

economic reasons having nothing to do with mitigating wildlife impacts, and there is no empirical evidence that any of these features have anything to do with bird and bat fatalities.

Q: Do you have any additional observations or recommendations regarding avoidance and/or mitigation measures?

A: If the Project is approved, the State of Washington should retain jurisdiction over the Project to require changes to the Project if necessary to reduce impacts to wildlife. TAC findings and recommendations should inform any such changes.

Based on my experience in the Altamont Pass, it is essential that a substantial performance bond be secured prior to the operation of the wind turbines, in order to ensure permit compliance and the capacity to provide offset or compensatory mitigation for impacts to birds and bats. The Application implies at page E-13 through E-14 that a performance bond will be provided for potential decommissioning of the Project, but does not expressly address financial assurances for mitigating wildlife impacts.

Even with the authority to impose additional mitigation measures after a project is built, and even with a performance bond to implement such measures, it should be understood that effective mitigation measures may not be readily available. In practical terms, there is usually little, if anything, that can be done to reduce bird and bat fatalities once wind turbines are installed. There is little evidence that fatality rates have been reduced by post-construction measures, other than shutdowns and increased turbine cut-in speed (*i.e.*, the wind speed at which wind turbine blades begin spinning).[39] By increasing the cut-in speed to 5 m/s in an experimental design established at the Casselman Wind Project in Pennsylvania, Arnett et al. (2009) reduced bat fatalities 53% to 87% with a projected annual power loss of 0.3%.[40] Unfortunately, no wind projects have yet adopted increased cut-in speeds, not even the Casselman Wind Project (personal communication, E. Arnett, 6 August 2010). Marginal evidence supports a conclusion that winter shutdowns of wind turbines decreased raptor fatalities in the Altamont Pass, but spikes in fatality rates following the early spring reactivation of turbines may have offset the gains from the winter shutdowns.[41] It is possible that effective post-construction measures could be developed for implementation, but this possibility will remain remote until fatality and utilization monitoring efforts are increased substantially, including much more frequent fatality searches, much improved understanding of searcher detection and scavenger removal rates, searches to greater distances from the turbines, much more frequent utilization surveys, and much greater use of spatial analysis and hypothesis-testing.

The unique characteristics of the Whistling Ridge site would make the effectiveness of post-construction mitigation efforts even more remote. The heavy forest cover at the site

would likely frustrate the detection of bird and bat carcasses during post-construction surveys, thus potentially underestimating the impacts of the project and in turn impeding awareness of need for mitigation.

Therefore, it is very important to carefully plan the installation of wind turbines, including tower height and wind turbine siting. Wind turbines should be carefully sited, and the siting should be based on adequate bird surveys, the results of which are related quantitatively to a resolute digital elevation model of the project site. In addition, tower heights and the low and high reaches of the rotor plane should be based on an analysis of adequate avian survey data.

Lee Neher and I have developed spatial models to predict hazard zones for specific species of raptor in the Altamont Pass, relying heavily on behavior and utilization surveys. Sufficient sample sizes of birds displaying specific flight behaviors, e.g., hovering, contouring, and fly-catching, are needed to inform the models, which also rely on a resolute digital elevation model of the project area so that slope and wind conditions can be measured and related to bird flight patterns. Our models are being implemented in two repowering projects (see Exhibit 22.04 as an example of the approach). Our approach or a similar approach should be utilized at Whistling Ridge, if the project is developed.

Q: Could you briefly summarize the major points in your preceding testimony?

A: The analysis by the Applicant's consultants of direct impacts caused by bird and bat collisions with wind turbines was incorrect and misleading. This analysis relied on the same methodology that has most often resulted in predicted fatality rates being proven much too low by post-construction monitoring. Measured raptor fatality rates have been up to 14 times higher than predicted fatalities.

The Applicant's consultants have relied on raptor fatality rates regressed on utilization rates, but this regression was fundamentally flawed in multiple ways.

- The regression between fatality rates and utilization rates was pseudoreplicated, meaning the effective study units were not the study units implied in the graph – they were regions instead of wind projects. The positive regression slope was strongly leveraged by two California wind projects, the omission of which reverses the direction of the regression slope.

- The effort directed toward avian utilization surveys totaled 87 hours, which was grossly insufficient for characterizing utilization rates of many species, especially golden eagle and other raptors.

- The utilization surveys were diurnal, so were not designed to detect species active in the early morning, evening, or at night.

- The utilization surveys were extended to 800 m from the observer, which ensured that most flying birds would be undetected during each survey session, and no attempt was made to account for the proportion of the sky over the survey area that was occluded by terrain and forest. For these reasons, the utilization survey results were not comparable to other wind farms or among plots within the Whistling Ridge project site.

- The regression slope between fatality rates and utilization rates relied on fatality rates that were biased low in most of the available monitoring reports. Most of the fatality rates in the Pacific Northwest were derived from an estimator that relies on mean days to removal of placed carcasses in carcass removal trials, but carcasses in these trials must be censored from the calculation of the mean if the carcasses have not been removed by the end of the trial. This means the trials must extend for much longer periods than the average search interval of the fatality monitoring, and that mean days to removal is biased high and the resulting fatality estimates biased low.

- The regression between fatality rates and utilization rates was based mostly on monitoring that lasted only one year, but the inter-annual variation measured at other wind projects revealed up to nearly 6-fold differences in low to high fatality rates between years. This high inter-annual variation warrants a much larger sample size before any validity can be given to the regression used in this analysis.

- The prediction of zero raptor fatalities at Whistling Ridge was fallacious because the prediction was based on the regression slope intercept being to the right of Whistling Ridge on the continuum of utilization rates among wind farms. In the very same graph, the slope intercept was also to the right of other wind farms where fatality rates were greater than zero.

It also appears that the Applicant's consultants have relied on an exposure index value to assess collision impacts of individual species. However, I tested the relationship between fatality rates and this exposure index at other wind farms, and found no relationship whatsoever.

The analysis by the Applicant's consultants appears to rely on a comparison of raptor nesting densities among wind project sites, but I was unable to find a significant relationship between fatality rates and raptor nesting densities.

Based on mean fatality rates estimated at other wind projects throughout Washington, Oregon and California, the minimum numbers of annual fatalities at Whistling Ridge would likely be 30 raptors, 406 birds (including raptors), and 95 bats, but actual rates would likely be much higher because unlike the other wind projects used to calculate the means, Whistling Ridge is located in a forested environment that is also frequently enveloped by clouds.

The impacts assessment directed to habitat fragmentation was also fallacious because the Application and DEIS characterized the site as biologically impoverished, whereas the mere 87 hours of avian surveys there revealed a much higher avian species diversity than occurs in the Altamont Pass—the site of the most notoriously dangerous wind energy project on Earth to birds. Furthermore, all but one of the 90 identified bird species were endemics, indicating a high level of ecological integrity at the site.

Impacts to northern spotted owl were inappropriately dismissed, because this conclusion relied too much on interpreting U.S. Fish and Wildlife Service protocols and not enough on wildlife biology or on the precautionary principle central to risk assessment applied to conservation.

The cumulative impacts analysis was fundamentally flawed in several ways. First, it relied on a cumulative impacts analysis of the Columbia Basin Ecoregion, but Whistling Ridge occurs in a forested environment outside this Ecoregion. Second, the analysis relied on a Partners in Flight web site to estimate regional population sizes of bird species, but the Partners in Flight estimator did not pass scientific scrutiny in the scientific literature and the population estimates used in the Whistling Ridge analysis were absurdly large. Third, reported avian fatality rates have been underestimated, so low fatality rates were compared to absurdly large population sizes to arrive at erroneous conclusions of no significant cumulative impacts. The cumulative impacts analysis cannot be taken seriously.

Based on means from available reports of fatality monitoring at wind projects in the western U.S., build-out of 6,700 MW in the neighboring Columbia Basin Ecoregion could be expected to annually kill at least 2,680 raptors, 36,314 birds, and 8,509 bats, far exceeding the annual death toll at the notorious Altamont Pass.

A new cumulative impacts analysis is needed for this project, and it needs to include the potentially unique impacts of siting wind turbines in the forested environment of Skamania County.

The DEIS listed several design features of the proposed wind turbines as preventive mitigation measures, but these features have not affected fatality rates and so are misleading.

Post-construction monitoring should last at least 3 years for all turbines, and throughout the life of the project for a subset of turbines. Fatality searches should be no less frequent than twice per month, and utilization surveys should be weekly.

Minimum standards are needed for Technical Advisory Committee membership, and the TAC should be given authority to select the monitor, and make or advise EFSEC about changes to the monitoring program and additional mitigation measures.

Wind turbines should be carefully sited, and the siting should be based on adequate bird surveys, the results of which are related quantitatively to a resolute digital elevation model of the project site.

Tower heights and the low and high reaches of the rotor plane should be based on an analysis of adequate avian survey data.

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