California Wind Energy Association

CalWEA

August 9, 2005

Chairman Joe Desmond
Commissioner James D. Boyd
Commissioner John L. Geesman, J.D.
Commissioner Jackalyne Pfannenstiel
Commissioner Arthur H. Rosenfeld, Ph.D.
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Dear Chairman and Commissioners,

As you may know, the wind industry has raised detailed and serious concerns about the validity of the conclusions in a 2004 PIER consultant report by Smallwood and Thelander regarding wind-avian interactions in the Altamont Pass Wind Resource Area.[1] In addition to comments submitted in the IEPR process,[2] CalWEA has since identified a number of instances in which the study appears not to have followed national guidelines for such studies. For example, an excessive number of correction factors were employed because of the limited number of searches conducted. In one case, the correction factors resulted in the carcasses of two brown-headed cowbirds producing an annual fatality estimate of 435 cowbirds. Further, we have identified errors in the calculations performed that, when corrected, significantly reduce the mortality factors for various species. The mortality factor used in the case of golden eagles, for example, appears to be in error by a factor of three. (See Attachments 1-3.) These comments and findings call into question the reliability of the conclusions made in the report.

Commission staff has relied upon this report and related documents in making a broad set of recommendations that are now feeding into the IEPR process. In addition, the report's mortality estimates and proposed mitigation measures are being inappropriately relied upon as proven by county governments, federal agencies, environmental litigators, the media, and most recently by the California Attorney General's office. This report has the clear potential to damage the wind energy industry throughout California and therefore threatens achievement of the state's RPS goals, while offering very little in the way of proven techniques for reducing avian fatalities.

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[1] Smallwood K.S. and C.G. Thelander, "Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area," PIER Final Project Report 500-04-052, August 2004.

[2] See the July 15, 2005, Reply Comments of the California Wind Energy Association and the Kern Wind Energy Association and the July 29, 2005, Reply Comments of the California Wind Companies in Docket No. 04-IEP-1G.

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We therefore request that the Commission immediately submit the Smallwood-Thelander report to outside review for examination of the validity of the methodological and statistical techniques and assumptions employed, and the conclusions drawn from them. The reviewer should have appropriate expertise and come from outside of either the Commission's or the wind industry's normal stable of consultants. Appropriate reviewers would include, for example, UC Davis's Avian Sciences Department, or UC Santa Cruz's Predatory Bird Research Group.[3] The reviewer should be presented with the report, all of the original raw data and all interim data tabulations and data summaries, along with the issues raised in the IEPR process by the wind industry and in the attachments to this letter regarding potential errors and methodological problems.

We respectfully request a response to this request by the end of August. A timely response and review is in order because, as stated by the California Wind Companies, the report is "gaining the force of CEC policy or rulemaking in the State of California," despite never having been subjected to the rigors of scientific peer review or public review, and never having been formally adopted by the Commission itself. The public urgently needs to know whether the report's conclusions are valid. The wind industry will welcome the results of an independent review because, as we have documented, we believe the conclusions are scientifically unsound.

In addition, we take this opportunity to make several related requests. First, the PIER program should immediately release all of the raw data and summary data tabulations from the Smallwood-Thelander report (only a portion has been released). It is very unusual for a publicly funded study not to release the data that underlie a report of this type. If the PIER staff did not take appropriate steps to ensure the availability of the data as it should have, it is incumbent upon the Commission to remedy the situation. As noted above, the independent reviewer will need this information to conduct a review.

Second, we urge the Commission to adopt and enforce a set of protocols for future wind-avian studies. In doing so, the Commission need not recreate a wheel. It can simply adopt protocols developed by the Avian Subcommittee of the National Wind Coordinating Committee. A primary co-author of this document was the Commission's former PIER biologist, Dick Anderson. The document represents the consensus of federal and state energy and resource agencies, wildlife research groups, environmental groups, the wind industry and others. (The executive summary of this report is attached as Attachment 4.) As indicated in Attachment 2, the Smallwood-Thelander report did not follow the NWCC guidance document, despite claims to the contrary (on page 13 of the Smallwood-Thelander report).

Third, we urge the Commission to ensure that all PIER reports are subject to appropriate scientific peer review, public participation and public review. As indicated in the Acknowledgements section of the report, many people were involved in the Smallwood-Thelander report, but the study was never subjected to comprehensive peer review. Likewise, drafts of the final report were never made available for public review.

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[3] Grainger Hunt would have to be excluded from the UCSC group, as he has served as a consultant to the PIER program.

Fourth, the Commission should direct the PIER staff to refrain from blurring the line between Commission policy and staff positions, a practice that was documented in the July 29 comments of the California Wind Companies.

Fifth, staff should refrain from publishing potentially misleading or inaccurate avian mortality data, as was done in the Smallwood-Thelander report and in staff documents feeding into the IEPR process -- and subsequently picked up in the media. Doing so inhibits the reasoned, scientifically based discussion of Altamont Pass avian issues that is needed at this time and that should be encouraged by all stakeholders. For example:

- Publicized wind-related avian mortality figures should distinguish between endangered or protected species and other species. Publishing a single total figure is misleading and may cause readers to overestimate the impact of wind farms on endangered or protected species.
- Estimates of total historical bird deaths should not be published unless they are made with a reasonable measure of confidence and bear some meaningful relationship to biological significance. Otherwise, they serve no purpose but to inflame the situation.

Likewise, staff should reference in their reports, such as those feeding into the IEPR process, the one study of biological significance that has been conducted (by the PIER program for golden eagles) that indicates that the studied avian population is stable. In addition, we would welcome research with a broader view, such as consideration of the effects on avian species of the encroaching housing developments around the Altamont Pass, how that development has affected concentrations of birds in the wind production area, and whether preservation of the pass for wind energy production rather than housing developments would be a relative benefit to avian populations.

Finally, as discussed in our comments in the IEPR process, we urge the Commission to reject for inclusion in the 2005 IEPR any statements, figures or recommendations that derive from the Smallwood-Thelander report and related documents. Any use of this information should await an independent review of the study.

We thank you for considering our request regarding independent review of the Smallwood-Thelander report, and look forward to your reply.

Sincerely,

/s/

Nancy Rader
Executive Director

Cc: B.B. Blevins, Executive Director
Martha Krebs, PIER Program Manager

Significant Calculation Errors Found in the August 2004 PIER Report[4]

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August 2005

Golden Eagle Mortality Factor

The mortality factor for golden eagles used in the PIER Report appears to be in error by a factor of 3. The reported factor is incorrect because it is not derived following the procedure explicitly stated by the authors as the calculation they performed.

The PIER Report is based on two sets of turbines, Set 1 and Set 2.[5] Set 2 data tabulations (provided to us by CEC staff) were used to evaluate the Set 2 mortality factor for golden eagles. Thirty-one golden eagle carcasses were found during Set 2 searches – of these, 10 were given an estimated time of death (ETD) prior to carcass discovery of less than 90 days, 6 were given ETDs of 90 days or more, and 15 did not have ETDs. The biologist's field notes for the 15 carcasses without ETDs are shown in Table 1 (the comments were truncated as shown).

The report defines a 'fresh' carcass as less than 90 days old (p. 52) and states that old remains were not used to estimate total APWRA mortality (p. 49). Using only the 10 'fresh' carcasses in Set 2 and the calculation procedure described (p. 49), the Set 2 mortality factor (deaths/MW/year) for golden eagles is 0.0485 – approximately a third of the 0.1391 factor shown in the report (p. 70). When all 15 carcasses with unassigned death dates are added to the 10 'fresh' carcasses, the calculated factor matches the Set 2 mortality factor (within 1%) – i.e., the old remains, bones, pieces and talon described in Table 1 were apparently used in calculation of the factor (there is no other obvious explanation).

The impact of including old remains on the reported Altamont-wide mortality is significant. When the Report's Altamont-wide mortality figure is corrected, the estimated 116.5 golden eagle deaths per year become 49.

Red-Tailed Hawk Mortality Factor

Set 2 included 56 red-tailed hawks, 25 of which were assigned ETDs less than 90 days, 16 assigned 90 days or longer, and 15 with no ETDs.. As with the golden eagles, the 25 'fresh' and 15 unassigned red-tailed hawks were apparently used to calculate the Set 2 mortality factor (our calculated factor matches the report's within 2%), again a significant error in calculation. When only the 25 'fresh' carcasses in Set 2 are applied to

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[4] Smallwood K.S. and C.G. Thelander, 'Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area', PIER Final Project Report 500-04-052, August 2004.

[5] Since the Set 1 data have not been released, it is unknown which carcasses were used to develop Set 1 mortality factors and if the same type of selection occurred.

the calculation procedure described (p. 49), the Set 2 mortality factor (deaths/MW/year) for red-tailed hawks is 0.0551 -- 40% lower than the 0.2490 factor shown in the report (p. 70).

Again, the effect of this error is significant. When the Report's Altamont-wide mortality is corrected, the estimated 300.4 red-tailed hawk deaths per year become 225.

Great Horned Owl Mortality Factor

Although these examples illustrate poor quality assurance in the data and calculations, as well as a significant lack of investigator oversight and critical review, it would be merely a procedural (although serious) error if it were applied evenly throughout the data set. However, 5 great horned owls were also found in the Set 2 searches – none was assigned a death date. Contrary to the inclusion of all unassigned hawks and eagles, *only one* Set 2 great horned owl carcass was selected from which a mortality factor was developed. Since only one, and not all, of the old owl carcasses was used, unassigned carcasses are apparently included in the calculations *not* as a procedural error but by conscious decision.

When the Report's Altamont-wide mortality is corrected, the estimated 10.1 great-horned owl deaths per year become 7.3.

Table 2 reproduces the reported annual mortality from the report (p. 73), considered the high and low values for the mortality uncertainty range for the species. Table 3 shows the mortality using the corrected factor with old carcasses omitted, calculated following the procedure the authors incorrectly indicated was followed in the report.

Table 1: Field notes extracted from the Set 2 golden eagle data.

Finding	Comment	Comment 2
prtl carcass	Unknown injuries. Too old.	Bones found on surface and below few inches of dirt and gras
prtl carcass	Unknown injuries. Too old.	Most bones found at or near the surface. Some bones scorched
prtl carcass	Unknown injuries. Too old.	Bones partially buried and some broken.
old remains	Unknown injuries. Only found broken Ulna bone.	
Wings	Unknown injuries. Most of carcass missing. Old.	
old remains	Unknown injuries.Too old.	Bones found on surface or below grass and 2-3 inches of dirt
feathers	Unknown injuries. Most of carcass missing. Old.	Weathered bones and feather found partially submerged in dir
old remains	Unknown injuries. Most of carcass missing.	Ulna had burn marks from fire in area. (Oct-02 Burn zone had
prtl carcass	Unknown injuries. Carcass missing.	Broken talon found on surface.
old remains	Unknown injuries. Too old.	Some small mammal bones found with GOEA bones. 20 degree slo
prtl carcass	Unknown injuries. Carcass too old.	Most bones buried and broken.
prtl carcass	Unknown injuries. Too old. Head and bones of one wing missin	Small mammal bones found in same area - last meal? Most bone
old remains	Unknown injuries. Only partial pelvis and spine found.	
old remains	Unknown injuries. Only found broken bones of one wing.	
old remains	Unknown Injuries. Only leg bones found.	

Table 2: Reported Altamont-wide mortality (deaths per year)

Species	Adjusted for search detection (low)	Adjusted for search detection and scavenging (high)
Golden eagle	75.6	116.5
Red-tailed hawk	208.9	300.4
Great horned owl	7.8	10.1

Table 3: Corrected Altamont-wide mortality (deaths per year)

Species	Adjusted for search detection (low)	Adjusted for search detection and scavenging (high)
Golden eagle	33	49
Red-tailed hawk	162	225
Great horned owl	6.1	7.3

Divergence of August 2004 PIER Report from NWCC Guidelines And Related Questions Regarding Confidence in Results

California Wind Energy Association
August 2005

We believe the following questions and comments are among those that should be considered in an independent review of Smallwood and Thelander (2004)[6]. Some are questions that we could not answer with the limited data available to us, some relate to the appropriateness of the evaluative procedures, and others to the reliability of the conclusions. The PIER report states (p. 13) that, whenever applicable, it adhered to the study guidelines of the National Wind Coordinating Committee ("NWCC Guidance").[7]

Search Frequencies

NWCC Guidance (p. 3) recommends a systematic sampling plan for long-term studies, and spreading the sampling effort throughout the study area and time periods of interest.

The PIER study itself emphasizes the importance of studies lasting a minimum of one year and preferably three. The first turbine set consisted of 1,526 turbines, arranged in 182 strings, and had a total power rating of 151 MW. Turbines in this set were searched from 4 to more than 25 times between May 1998 and September 2002. The second turbine set had considerably more turbines than the first (2,548 turbines, arranged in 280 strings, with a total power rating of 267 MW), but had only two searches and a 150-day study duration.

How does the use of the Set 2 turbines affect the confidence we can place in the findings?

Since the Set 2 turbines were not searched at all in summer, how much confidence can we give to associations of species fatality with season? How much confidence can we give to associations of species mortality and turbine attributes? How much do these associations change when the Set 2 turbines are removed?

The shortest search interval – i.e., number of days between searches – for the Set 2 turbines was 72 days; the longest 118 days. The number of searches per year shown for this set ranges from 6 to about 9.5 searches per year (Figure 3-2, p 50). For a 72-day interval, 10 searches would take 21 months (if the first search was on 1 January 2003, the 10th search would take place on 10 October 2004). For a 118-day interval, the 6th search would occur in the 20th month. Is Figure 3-2 an accurate depiction of searches? The PIER report states (p. 47) that the strings in the study had an average of 7.2 searches per year; since all of the Set 2 strings were searched less frequently, is this statement correct?

Is Figure 3-1 (p. 49) an accurate depiction of search frequency?

Since modern fatality monitoring studies have frequent (≤ 4 week intervals) and regular carcass searches, shouldn't the variability and uncertainty in the mortality extrapolations in the PIER study, caused by long and irregular search intervals, be thoroughly discussed? Is the magnitude of uncertainty in the PIER findings commonly acceptable in professional or academic studies?

Is it accepted practice to give mortality estimates such prominence in a study that appears to be designed to examine avian mortality associations with bird behavior and turbine, landscape and environmental attributes? Is the emphasis on discounting the mortality estimates produced by other researchers justified?

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[6] Smallwood K.S. and C.G. Thelander, 'Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area', PIER Final Project Report 500-04-052, August 2004.

[7] Anderson, R., M. Morrison, K. Sinclair and D. Strickland, 'Studying Wind Energy/Bird Interactions: A Guidance Document', National Wind Coordinating Committee, December 1999.

Strings and Extrapolations

NWCC Guidance (p. 3) recommends that study plans should be peer reviewed with an emphasis on developing comparable and credible information. It also states (p. 21) if the objective of the study is statistical inference to the entire area, and the sampling is restricted to a subjectively selected portion of the area, the objective of the study cannot be met with the study design, and that the inference to the entire area is reduced from a statistical basis to expert opinion.

The PIER report states, 'Mortality at the SeaWest-owned portion of the APWRA substantially exceeds mortality observed over the rest of the APWRA' (p. 76). Was it appropriate to extrapolate these mortality data to the rest of the APWRA?

When extrapolating mortality from turbine sets to the Altamont as a whole, is it appropriate to normalize using MW rather than strings, since the calculation within the sets produces a deaths/MW/year factor that is an average for the strings in the set, not the MW in the set?

Do string length and total MW in the string relate to mortality? Was string length, or string total MW, evaluated for its association to mortality? Do not isolated turbines and short strings contribute disproportionately to mortality extrapolations via this calculation method?

No other study of which we are aware uses a string-based calculation of mortality. Is this not counter to the NWCC recommendation for comparable data?

Selection of turbines studied was based solely on agreement of the owners/operators to grant access. Should the lack of a statistical basis for the extrapolation of mortality to the entire APWRA have been discussed?

'Correction' Factors

NWCC Guidance (p. 22) recommends that study methods be selected to minimize bias in the outcome of the study, and that bias can be tolerated if it is relatively small, measurable, or consistent among study areas.

Is it reasonable for all non-raptors to be given the 2.4 carcass multiplication factor from the small-bird searcher detection trials performed by WEST[8] at the Stateline project? Game bird chicks and house sparrow carcasses were used in the small bird trials. Would it have been more appropriate to use the 1.3 carcass multiplication factor from the mid- to large bird trial for larger non-raptors, such as mallards and rock doves? The mid- to large bird trials used pheasants and rock doves.

In its correction for scavenging, the PIER report used the percentage of carcasses removed in 40 days in a scavenging trial from another study, and corrected for carcass scavenging by dividing the found carcasses by the percentage of carcasses presumed removed. In adjusting for scavenging, is it correct to use a factor that presumes all the scavenged birds died on the first day of the interval?

When two brown-headed cowbird carcasses are extrapolated to annual fatalities of between 44 and 435, does this meet the NWCC criterion for bias minimization?

Among the 1,162 total carcasses attributed to wind turbines, one cockatiel carcass was found. Does the projected 'all birds' annual total fatalities include cockatiels? Could a cockatiel (a tropical bird typically kept as a household pet) in the Altamont in February have died from some other cause than wind turbines?

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[8] Erickson, W.P., J. Jeffrey, K. Kronner and K. Bay, 'Stateline wind project wildlife monitoring annual report', 2003.

Why do the species-specific mortalities corrected for searcher efficiency plus scavenging add up to 11,000 while the 'all birds' estimate is 4,700? Why do the species-specific raptor mortality estimates add up to 1,200 while the 'all raptors' estimate is 1,300?

The number and range of correction factors, both in mortality estimates and association of mortality with turbine and landscape attributes, seems excessive: variability in relative search effort by season, turbine type, turbine location and landscape features; study duration multiplication factors of 0.25 – 2; searcher detection factors of 1.2 – 2.4; scavenging factors of 1.2 - 10; and species-specific searcher factors of 1 – 2. Given these, how accurate is the PIER report statement that the searcher efficiency-corrected mortality represents the low value and that the combined searcher efficiency and scavenging-corrected mortality represents the high value of the uncertainty range in the avian mortality estimate for the APWRA?

Recounts and Turbine Kills

NWCC Guidance (p. 19) states 'In a perfect world, impacts would be measured without error. For example, bird fatalities on the site of a wind plant could simply be counted. However, when a complete count or census is impossible, then impacts must be detected through the use of scientific study and statistics.

Of the 131 'fresh' carcasses in Set 2 used to estimate mortality, only 24 (18%) were complete carcasses; most were feather spots (43%) and many were partial carcasses (28%). Since carcasses and all feathers were not removed when they were first found, how certain is it that a carcass was not moved by scavengers and found in another location on subsequent searches? How certain is it that a single carcass did not become several body parts and feather spots subsequently found and counted as several more carcasses?

How many feathers did it take for a feather spot to be defined as a carcass? Is the number reasonable?

Carcasses identified as turbine-caused as well as those with unknown causes of death were used for mortality projections and turbine and landscape comparisons to mortality. Only birds with known causes of death (automobiles, electrocution, etc.) were removed from the turbine-associated total. The biologist comment for one immature bird in Set 1 indicated the carcass was likely due to exposure or a fall from the nest. Since the cause of death for this bird was designated as unknown, it was apparently attributed to turbines. Other immature bird carcasses were found that did not have this comment, and although it is difficult to determine how a flightless bird could die from turbine collision, they apparently were included in the turbine-associated carcasses as well. If flightless birds were included in turbine-associated carcasses, is that practice justified? How many similar errors in mortality attribution may there be and, when corrected, how are the results affected?

NWCC Guidance recommends (p. 3) that when data are unavailable before construction, multiple reference areas should be used and combined with other study designs such as the gradient-response design.

Is it reasonable to assume that carcasses found outside of the search area were due to wind turbines? Is magnification of these distant carcasses using species-specific additional search detection factors counter to the gradient-response study design?

Should background mortality have been evaluated through searches of reference sites?

Scientific Certitude

Is it reasonable to state that the low and high ends of the uncertainty range in ferruginous hawk mortality is 15 and 24 when only two ferruginous hawk carcasses were found in the entire 4+ years of the study?

In the data files, there are many carcasses designated in the searcher notes as possible relocations of carcasses previously found. Were the possible relocations removed from the tabulations of total carcasses so that mortality projections were not affected by them? If not, how does a correction for this error affect the results?

In the evaluation of associations between mortalities with wind turbine attributes and landscape features, both the Set 1 and Set 2 turbines were used, with a correction made for the variable search effort. Because of the study durations, Set 1 turbines (searched 4 years) seem equivalent to 0.25 carcasses and a carcass from a Set 2 turbine (with a half-year study duration) seems equivalent to 2 carcasses. If this is the case, any Set 2 carcass would outweigh any Set 1 carcass in the evaluation because of the longer study duration for Set 1. Were the corrections applied in this way? If so, is the result statistically valid?

NWCC Guidance (p. 19) states that statistical or inductive inferences are made properly in reference to the specific time period of the study.

In the Set 2 turbines, two kestrels, one golden eagle and one red-tailed hawk were found more than a month after formal searches of these turbines ended, and yet they are tabulated among the Set 2 carcasses. It appears there are several carcasses found after the end of the study period among those in Set 1 as well. Were these used in the mortality projection and associational analyses? Is use of these carcasses appropriate? If they were included, what search effort, scavenger and searcher corrections and study duration was used for these carcasses?

NWCC Guidance (p. 60) states that testing model predictions using the same data that were used to develop the model would be a biased validation.

Were hazardous turbines identified correctly, given that the models were not validated against an independent data set? Four amended versions of the models have been produced – is this accepted practice? Are the models accurate enough to make irreversible decisions regarding turbine removal?

Example of Correction Factors Used in August 2004 PIER Report: How a Single Cowbird Carcass and Feathers Turned Into 435 Fatalities

California Wind Energy Association
August 2005

We document here how wind-avian fatality estimates in the August 2004 Smallwood-Thelander Report rely on an excessive number of overly large correction factors. These correction factors were employed because of the short study duration and the limited number of searches as well as the long interval between the two searches conducted in the study.

Molothrus ater

Brown-headed cowbirds are medium-sized birds, growing up to eight inches long. Cowbirds live in fields, parks and thickets and eat seeds from weedy plants as well as insects. The bird is best known for its breeding habits—they do not build a nest or raise their young. Instead, after mating, female cowbirds lay their eggs in the nests of other birds. Then they fly away, never to return. Predators of the brown-headed cowbirds include hawks, owls, raccoons, squirrels and snakes.

The Study Sets

Set 1: 1,526 turbines, arranged in 182 strings, with a total power rating of 151.165 MW, were searched from 4 to more than 25 times between May 1998 and September 2002.
Set 2: 2,548 turbines, arranged in 280 strings, with a total power rating of 267.09 MW were searched twice between October 2002 and April 2003.
Set 3: 1,326 turbines, with a total power rating of 161.750 MW, were not searched.

Set 1 total MW: 151.165
Set 2 total MW: 267.09
Set 2 number of strings: 280
Set 3 total MW: 161.750

The Carcass

On October 30, 2002, feathers from a brown-headed cowbird were found by a pond 131 meters (430 feet) down the hill from the closest turbine tower (299) in the Patterson Pass wind park. Notwithstanding its location and distance from the turbine, it was assumed to be a wind power fatality rather than, for example, a hawk's lunch. It was assigned BRC number 1270.

Number of carcasses: 1

The Turbine String

Tower 299 is part of a 2-turbine string. Although the turbines are 65 kW machines, they were incorrectly identified as 150 kW turbines in the report; for consistency we will use 150 kW in this exercise. The turbines were searched twice (October 31, 2002 and February 11 2003) as part of the second study set in the CEC report.

Total string (MW): 0.3

The Study Duration
In the data for this study, discovery dates in all cases reviewed precede the search dates by one day; the reason is not known, but this does not change the calculation. Carcasses judged less than 90 days old were used for the calculation, so 90 days were added to the duration of the study (the 103 days between the search dates) to adjust for the period before the first search.

Study duration (years): 0.529

Cowbird Mortality for Set 2 Turbines:
Carcass count ÷ string MW ÷ study duration = deaths/ MW/year for that string
Deaths /MW/year (string) ÷ total number of strings = deaths/MW/year for the set. No weight was given to short strings (1 turbine) or long strings (62 turbines).

1 ÷ 0.3 ÷ 0.529 = 6.30 d/MW/y for the string;
6.30 ÷ 280 = 0.0225 d/MW/y for Set 2 from this calculation
Reported set 2 d/MW/y: 0.0227

Calculating Cowbird Mortality for Turbines not Searched (Set 3)
The MW-weighted average for Sets 1 and 2 turbine mortalities was applied to Set 3 turbines.

Reported set 1 d/MW/y: 0.0033

Cowbird Mortality for Set 3 Turbines:
(d/MW/y set 1 × MW set 1 + d/MW/y set 2 × MW set 2) ÷ (MW set 1 + MW set 2)

(0.0033 × 151.165 + 0.0227 × 267.09) ÷ (151.165 + 267.09) = 0.0157 d/MW/y

Unadjusted Total Altamont Mortality
d/MW/y set 1 × MW set 1 + d/MW/y set 2 × MW set 2 + d/MW/y set 3 × MW set 3

0.0033 × 151.165 + 0.0227 × 267.09 + 0.0157 × 161.750 = 9.10 deaths/year

Adjustments
It was assumed that searchers did not find all of the carcasses in the study plots. It was assumed that if one carcass was found, there must have been more of them to start with.

Searcher Efficiency
From Erickson et al. (2003) and Johnson et al. (2002) a 41% searcher detection of small bird carcasses was used. When any carcasses were found beyond the 50 m search radius, a species-specific factor was added. This served to inflate, rather than diminish, the importance of distant carcasses. Since one cowbird was found < 50 meters from a turbine (in the first set), and one was found >50 meters from a turbine (the Set 2 feathers), an additional 50% of cowbirds in each set was assumed missed, so a detection rate of 20.5% was used for cowbirds.

Set 1 & 2 searcher efficiency multiplier: 4.88

Scavenging Rates

From Erickson et al. (2003), the scavenging rate of small bird carcasses at the Stateline wind project in Oregon and Washington (80.2% carcass removal in 40 days) was applied to the Altamont for Set 1. The average Set 1 search interval was 53 days. Because the Set 2 search interval was longer (90+ days) 90.2% of carcasses that might have been there were assumed to have been removed. 100 ÷ scavenging rate = scavenging rate multiplier

Set 1 scavenging multiplier: 5.05
Set 2 scavenging multiplier: 10.2

Searcher Efficiency-Adjusted Total Altamont Mortality

d/y × search efficiency factor (since the factor was uniform across sets)

9.10 × 4.88 = 44.4 cowbird deaths/year from this calculation
44.3 reported

Scavenger and Searcher Efficiency-Adjusted Altamont Mortality

In this case, the scavenging factor was unequal across sets (5.05 vs. 10.2), so the Set 1 and Set 2 d/MW/y are multiplied by their factor, a MW-weighted set 3 factor recalculated, and the Altamont scavenger-adjusted total multiplied by 4.88 for searcher efficiency.

434.9 cowbird deaths per year from this calculation
434.9 reported

A Demonstration of the Impact of Varying Parameters

Since the Smallwood and Thelander (2004) study is the only one known to the author using a string-based measure of mortality, the direction and magnitude of mortality change as parameters are varied is not necessarily intuitive. It is not initially obvious, for instance, that the procedure can result in an estimate of annual mortality lower than the number of carcasses actually found (as in the cattle egret, below). For all but the set-based comparison, variability added by the study duration was removed by using the mean duration in the calculations, and the turbines in Set 2 were considered the entire population.

Deaths per MW vs. Deaths per Turbine

Species	Carcass #	Deaths/Year (MW basis)	Deaths/year (Turbine Basis)
Brown-headed cowbird	1	6.1	1.9
Cattle egret	1	0.63	1.9
Common raven	1	2.4	1.9
Ferruginous hawk	2	9.3	3.8
Mountain bluebird	2	4.6	3.8

Search duration was set at the average (0.526 y) and total mortality (unadjusted) is only for set 2.

Effect of Turbine Power Rating and String-Length

Species	Carcass #	Turbines in String	Turbine kw	Deaths/year
Common raven	1	5	150	2.4
Ferruginous hawk	1	5	65	5.6
Mallard	1	6	100	3.2
Cattle egret	1	29	100	0.63

Search duration was set at the average (0.526 y) and total mortality (unadjusted) is only for set 2. Calculated by MW method.

Effect of Turbine Set on Total Mortality

Species	Carcasses		Mortality (deaths/year)		
	Set 1	Set 2	Set 1 only	Set 2 only	Reported
Golden eagle	15	10	34	163	116
Ferruginous hawk	0	2	0	38	24
Brown-headed cowbird	1	1	47	655	435
Mountain bluebird	2	2	49	310	216
Mallard	28	1	306	68	154
Horned lark	22	0	319	0	115

Total scavenging and searcher-corrected mortality for the entire Altamont using data only from set one, only from set 2, and as reported.