California Wind Energy Association

WHISTLING RIDGE ENERGY LLC
K. SHAWN SMALLWOOD
OCT. 24, 2006 LETTER FROM CALWEA
EXHIBIT NO. 22.05C

October 24, 2006

Jackalyne Pfannenstiel, Chair
California Energy Commission
1516 Ninth Street
Sacramento, CA 94814

Dear Chair Pfannenstiel:

With this letter, the California Wind Energy Association transmits to you three independent reviews which we commissioned of the consultant report, "Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area" by K. Shawn Smallwood and Carl G. Thelander of BioResource Consultants (August 2004; CEC publication # 500-04-052) ("2004 Report" or "report"). We also make three related requests.

As you may know, CalWEA and others in the wind industry have been highly critical of the quality of this report, particularly as it became clear that it was being relied upon not only by this agency, but by other government officials, including the California Attorney General's office and the Alameda County Board of Supervisors, in making important policy and law enforcement decisions. Unfortunately, the report has also fueled anti-wind efforts around the globe because the report's estimates of avian fatalities in the Altamont are significantly higher than those found in previous studies.

CalWEA documented its concerns in materials we filed in the Commission's 2005 IEPR process (Docket No. 04-IEP-1G) and in a September 23, 2005, letter to Commission management requesting an independent review of the report. In January 2006, we were informed by management that a peer review had been conducted, but this review was apparently abandoned after we pointed out that two of the three reviewers were business associates of the report's authors, one of which has been a vocal industry critic. In March 2006, Commission management initiated an independent review, but one that would intentionally not be focused on a review of the source data, despite CalWEA's request that this be done. It is our understanding that the Commission now has the results of that review, though the review has not been made public.

CalWEA believes that achieving California's ambitious renewable energy and greenhouse gas reduction goals will require solid, transparent science. To that end, we commissioned three separate independent reviews of the 2004 Report. Our reviews were conducted by Dr. William Warren-Hicks, an environmental statistician at EcoStat, a consulting firm specializing in quantitative environmental sciences, Dr. Eric Smith, an environmental statistician and interim chair of the statistics department at

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Virginia Tech, and LPL Quality Services, an independent quality assurance firm whose clients include U.S. EPA and FDA.

The reviews were based on the portion of data that has been made publicly available by the Commission – the Commission still has not provided the balance of the data despite a Public Records Act request by one of CalWEA's members, Pilz & Co.

The reviews we commissioned document a wide variety of serious mistakes in the 2004 Report, including these:

- No discussion of data quality and control issues, which should be clearly described in any scientific report, particularly one in which the report findings are statistically-based.
- Numerous data quality issues – any of which could have a substantial impact on the findings of the report – including duplicate and missing data records, possible unexplained changes to the original field forms, inconsistent coding of species type, and other translation errors between field forms and the electronic database.
    - For example: in 72% of field data sheets (81 of 113) where the field biologist indicated complete uncertainty as to the cause of death, the database attributes cause of death to "turbine collision" with no explanation given. These data points were used to develop associational relationships between turbines and fatalities.[1] The 81 field sheets with altered causes of death account for 30% of the 270 field sheets made public by the CEC.
- Lack of sound statistical design and analysis, including incorrect use of regression models and misinterpretation of regression model results which form the basis for reported turbine-fatality associations.
- Errors in calculations.
- Mortality rates for 11 of 17 species that could not be reproduced.[2] All but one of the errors had the effect of increasing estimated mortality.
    - The most troubling discrepancy was in the reported figure for the species of greatest concern, the golden eagle: the reported mortality rate for golden eagles was 2.6 times what is supported by the released portion of the data.

While it is not possible for the reviewers to conclusively determine whether the report's findings are in error (because the full dataset is needed to make that determination and the Commission has not made the full dataset public), it would be pure coincidence for a correct analysis to produce the same fatality-turbine associations, given the breadth and depth of errors found. And, as indicated by the summary of findings above, it appears that the overall mortality estimates were inflated compared to what is supported by the available data.

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[1] The Altamont Pass has a large avian population and will therefore have natural avian mortality as well as mortality caused by pesticides, predation, and disease (together, this is referred to as "background mortality"). For example, the lifespan of golden eagles and ferruginous hawks is about 20 years; therefore, absent unusual conditions such as fire, about 5% of these populations can be expected to die each year of old age. Background mortality would be higher when other threats are taken into account. A control study has never been conducted in the Altamont to determine naturally occurring mortality levels.

[2] The mortality rate, or "mortality factor," is used to extrapolate reported deaths/megawatt/year to produce overall estimates of annual fatalities.

Given the unreliability of the 2004 Report's conclusions, CalWEA makes three requests:

(1) that the Commission take affirmative public steps to ensure that this report – and others that are based upon it[3] – will not be relied upon in future government decision-making[4];

(2) that the Commission undertake an internal investigation to determine how its internal procedures failed to ensure quality science and implement procedures to ensure the scientific quality of its future research by implementing quality assurance and quality control procedures. It is our understanding that the Commission has no such procedures in place.

(3) that the Commission institute policies to ensure that all data supporting any future research funded by the Commission is made publicly available as a matter of course, and that the Commission obtain and release the balance of data associated with the 2004 Report.

We urge that the above steps be taken immediately, given the ongoing research being conducted by the Commission's PIER unit on wind-avian impacts, including a $1 million research effort that will soon be launched to support the Commission's wind-avian guidelines that are now being drafted. CalWEA supports further publicly funded research on wind impacts on birds and bats, but will not have confidence in the research that the CEC undertakes until these steps are taken. As the CEC's involvement in this research is necessary, we urge you to take these steps immediately.

In criticizing this report, we wish to make it very clear that the industry does not deny the relatively high level of avian fatalities that occur at the Altamont as compared to wind resource areas across the state and country. Rather, we are extremely troubled by the quality of CEC PIER-sponsored science and the absence of quality assurance procedures that enabled such a flawed report to be published and then promoted by CEC staff as a proper basis for the expenditure of millions of dollars despite the raising of many red flags. Most unfortunate is that the Commission has withheld portions of the data that support this taxpayer-funded report, preventing independent verification of the results to be made.

The industry is working actively to find ways of reducing Altamont avian mortality. But effective solutions will require open scientific debate and government agencies that are accountable for the scientific research that they sponsor. No one is served – least of all California's wildlife – by inaccurate research that could result in the ineffective expenditure of the limited resources that are available to address avian issues while preserving the viability of clean energy production.

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[3] The following reports, and perhaps others, are based in part on the 2004 report:

(a) Smallwood, K.S., and L. Neher. 2004. Repowering the APWRA: Forecasting and Minimizing Avian Mortality without Significant Loss of Power Generation. California Energy Commission (CEC-500-2005-005).
(b) Shawn Smallwood and Linda Spiegel, "Assessment To Support An Adaptive Management Plan For The APWRA" California Energy Commission, 19 January 2005.

[4] These steps might include a public statement that conclusions of the 2004 Report are unreliable, removing the report from the CEC's website, and/or posting the reviews we commissioned on the CEC's website alongside the 2004 Report.

The debate on wind-avian siting decisions must be informed by good science if California is to meet its renewable energy and greenhouse-gas reduction goals. Securing our energy future and ensuring good environmental stewardship depend on it.

We would like to meet with you at your earliest convenience to discuss our requests. We believe that a response from the Commission is warranted.

Sincerely,

Nancy Rader
Executive Director

cc: Vice Chair James Boyd
Commissioner John Geesman
Commissioner Art Rosenfeld
Commissioner Jeffrey Byron
Executive Director B.B. Blevins

Attachments:

EcoStat Altamont Report Review
EcoStat Comparison of SPSS and Field Form Data
Smith Letter & Review
LPLQS Audit Report
CalWEA Appendix to LPLQS Audit Report

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October 24, 2006

Nancy Rader
Executive Director
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Dear Ms. Rader,

Attached is a review of (1) Chapters 1-4 of the document entitled *Developing Methods To Reduce Bird Mortality In The Altamont Pass Wind Resource Area* which was prepared by BioResource Consultants for the California Energy Commission, and (2) the LPL Quality Services audit report which was prepared for CalWEA. The review focuses on the quantitative methods from which the document's conclusions are drawn.

Unfortunately, the report contains a large number of issues associated with the use and interpretation of statistical methods, and statistical practice. These unresolved problems serve to severely reduce the confidence in the report's findings. The report does not supply sufficient information from which the reader can make a judgement on the validity of the statistical findings. Since most of the conclusions drawn in the report are based on the use of statistical hypothesis testing techniques, the poor statistical practices observed throughout the report reduce the overall confidence that can be placed on the overall findings. Most of the issues revolve around the selection of an appropriate model, testing of model assumptions, and correct interpretation of the statistical outputs.

Additionally, the report does not directly address the influence of the survey design changes that occurred during the course of the study on the report findings. And, the report does not include the standard chapter on data quality. I cannot tell if proper chain-of-custody techniques were followed or proper quality assurance and control methods were applied.

A review of the LPL Quality Services audit report and associated documentation indicates substantial discrepancies between specific species mortality rates calculated by CalWEA and those reported in the Altamont report. The largest discrepancy is associated with golden eagle mortality. The methods and approaches used by CalWEA to calculate the mortality rates seem reasonable, particularly since comparable equations were not contained in the original Altamont report.

Good analytical and statistical practice requires that data used in the mathematical models accompany the report. I found myself confused over a variety of issues, and a data listing would certainly have aided in my interpretation of the report narrative.

The LPL Quality Services audit report findings point out the need for a quality assurance discussion in the report. The Altamont report presents no information on the treatment of data, an issue that could contribute to the differences in mortality calculations between CalWEA and the BioResearch report. I strongly urge the California Energy Commission to make the data underlying the report available to outside investigators for future study.

I believe that the Altamont data set is rich, and a great deal of information could be gleaned from the data. Findings based on the data must be supported by proper data analysis techniques and careful interpretation of the statistical findings. I recommend that further analysis and review of the data be undertaken in an effort to resolve the issues I have raised in my review.

I have provided a straightforward and unbiased review, as if I were reading a journal article prior to publication. I hope that you find the review insightful.

Sincerely,

[submitted by email]

William Warren-Hicks, Ph.D.
CEO

Review Of:
Methods To Reduce Bird Mortality In The Altamont Pass Wind Resource Area

The following is a review of the document entitled *Methods To Reduce Bird Mortality In The Altamont Pass Wind Resource Area* which was prepared by BioResource Consultants for the California Energy Commission. Specific comments are detailed below. The review focuses on the quantitative methods from which the document's conclusions are drawn. In addition, comments are provided on the results of an audit prepared by LPL Quality Services.

Comments on the BioResource Report

Chapter 1. Understanding The Problem

1. Section 1.1 Introduction, p. 7: The framework for the study seems logical and concise. I would expect that the statistical analyses provided in the report will provide insights into the biological and physical relationships described in the Introduction. In addition, I would expect that the survey design was generated with these relationships in mind.

2. Section 1.1.2, p. 9: I find the discussion of chi square confusing. The equation as written on p. 9 is not the typical chi square statistic form, and the ratio that is provided is not presented in a test statistic or a standard model form. Therefore, I cannot confirm whether or not the application of hypothesis testing methods based on chi square tests of association were performed correctly.

The authors do not present a well developed model. What is the model? The narrative is confusing: is the metric flight time, or is it the number of sampling periods? Are the sampling periods uniform; if not, how are non-uniform sampling periods addressed? If the metric is flight time, why are the authors applying chi square, a distribution typically associated with integer counts, to a continuous variable? In this case, chi square is certainly not the distribution of choice.

Also, the narrative does not convince me that $E(n_i) = Np_i$, nor does the narrative convince me that $\sum p_i = 1$ (i.e., basic assumptions underlying the test statistic). The equation on p. 9 is not a model (as stated), nor is it the correct form of the chi square test statistic (as indicated).

In addition, the narrative suggests that there are a variety of wind turbine types and environmental settings of interest. If so, it strikes me that (1) a correctly formulated model would explicitly contain these elements, and (2) the model would follow from the survey design.

On page 10 my confusion grows. If as stated, n= number of individual birds killed and N=total number of species killed, how is the ratio of individuals to species interpreted? In any case from a statistics perspective, I can't imagine how $E(n_i)$ equals Np_i, when clearly one term is in units of individuals and the other term is in units of species.

All hypothesis testing techniques are sensitive to sample size, including those using the chi square distribution. Were any attempts at testing the sensitivity of the hypothesis testing results to sample size undertaken?

I believe I understand what the authors are attempting. As written however, I have no confidence that the chi square distribution was correctly generated and interpreted. In a larger framework, I suggest the authors attempt to develop a full model (e.g., a loglinear model or other categorical data analysis function, or possibly a mixed model form) that reflects the survey design. The authors should be careful to describe the underlying model assumptions and provide documentation that the model assumptions have been met. Hypothesis testing with survey data is full of pitfalls, and therefore not generally recommended when other approaches are available. As presented, this section provides me with little confidence that the standard hypothesis testing issues were addressed sufficiently, or in a way that lends credibility to the report findings.

3. p. 11 - top of p. 12: The authors need to be cautious in their interpretation of the chi square hypothesis test results. The model the authors seem to be establishing is that mortality rate is a function of the number of wind turbines, with the expected number of mortalities directly proportional to the number of turbines. If the null hypothesis is rejected, it does not infer that "an association exists between that environmental element and mortality." Hypothesis testing results do not infer cause-and-effect, nor do they infer correlation or association. I see nothing wrong in building the ratio of observed to expected mortalities consistent with the above hypothesis, isolating those regions where the ratio is greater than one, and then more fully exploring why those regions are different than other regions. However, hypothesis testing cannot infer the causative relationship that the paragraph implies.

4. Sections 1.2 and 1.3: I found these sections interesting and well written.

Chapter 2. Cause of Death And Locations of Bird Carcasses in the APWRA

5. The histograms presented in this chapter were well constructed. However, the authors should provide a graphic illustrating the data used for each of the statistical tests that are performed throughout this section. For some variables (e.g., number of bird fatalities per season) the graphics are provided, however, I could not find corresponding graphics for all variables (e.g., blade tip speed).

6. The report notes that 1,189 carcasses were found in the study area. However, some histograms seem to use less than 1,189 observations. Please explain.

7. Figure 2-1, p. 29: Note that the use of a standard deviation is inappropriate for data that are not normally distributed (e.g., body length). The authors have made similar mistakes throughout the report. I suggest that other descriptive statistics that do not rely on the normality assumption be included in the graphics (e.g., range, median, quartiles, etc.). The incorrect normality assumption employed throughout the report may invalidate many of the report's findings.

8. Section 2.3.2, p. 38: The authors note that data beyond the survey design search range are used in the graphics and statistical tests in this section. Yet, the survey design protocols are not

explained. How far did the searcher roam beyond the 50m limit? Was the extreme boundary consistent throughout the study time period? The graphics and statistical results illustrate that the birds found beyond the 50m boundary have a strong influence on the report's findings. At the least, the authors should supply a sensitivity study illustrating how the study's conclusions would change if the data beyond the 50m boundary were not incorporated into the statistical analysis.

9. Section 2.3.2: Unfortunately, the approach used to build and interpret the ANOVA results throughout this report is flawed. In many cases the graphics are not consistent with the reported ANOVA findings, leading me to further question the ANOVA procedures employed by the authors (see below). Generally, the statistical outputs should be consistent with a visual interpretation of the graphics illustrating the data used in the statistical model. I am concerned that this type of inconsistency appears throughout the report. As noted above, the authors seem to employ a normality assumption. However, environmental survey data are generally not normally distributed. This error directly affects the validity of the hypothesis testing procedures employed throughout the report. Since the report's conclusions are directly drawn from the statistical outputs, I cannot confirm the report's findings that are based on the ANOVA results.

The following are issues, and proper statistical practices, that must be addressed if ANOVA models are used to generate a basis for the report's findings:

- The ANOVA model should be consistent with the survey design. The authors use a one-variable-at-a-time approach (i.e., one-way ANOVA). The result is a weakened model error structure resulting in little ability to detect actual treatment mean differences. Developing an appropriate model will take discussion and effort, but the resulting statistical outputs will be interpretable.

  As an illustration of the poor statistical approach see p. 42, the ANOVA on wind direction. The ANOVA and means test have 1 degree of freedom, effectively resulting in a modified t statistic test of the null hypothesis. This hypothesis would be much better examined in the context of the full model. As implemented, this is poor statistical practice.

- The model error assumptions must be examined before the hypothesis testing results can be interpreted. I did not find any discussion of data transformation or testing of residuals in the report. This is a severe error and should be corrected.

- The authors use a LSD multiple comparison test. There is an abundance of literature on the proper selection of multiple comparison test methods and many opinions on the best method to use. Generally, most statisticians will recommend using several methods (Duncan's, Tukey, etc.) in an effort to find consistent results among the various approaches. I recommend that the authors present the results from several methods.

- A key issue impacting the interpretation of hypothesis testing results is associated with sample size. For a fixed Type I error rate and variance, simply increasing the

sample size will eventually result in the finding of a "significant difference." The ANOVA models are run on large data sets, thus, the ANOVA outputs should be placed in the context of a biologically-defined significant difference, rather than a statistically-defined significant difference.

- Naive acceptance and decision-making simply based on the ANOVA outputs (as the case in this report) must be avoided. The authors should provide the reader with additional information (e.g., mean values or mean differences) so the reader can interpret the ANOVA results.

- Equations associated with each ANOVA model should be included in the report. Without a mathematical representation, confusion over the model cannot be avoided. A full model reflective of the survey design should be developed and tested.

- An appendix containing the data used in the ANOVA models should be included in the report. Given the confusion noted above, I believe it is important that outside researchers be able to confirm the report's findings.

10. Section 2.3.2, p. 38, Tower height ANOVA: I provide the following comments on this ANOVA model, but similar comments can be made consistently throughout the report on many of the other ANOVA models and approaches used by the authors.

The authors provide information showing that the ANOVA model was significant and that carcass location (distance from the tower) is a function of tower height. The authors state that there are 5 ranges of tower heights used in the model. The authors also present a regression model of distance (m) as a function of tower height (m).

- Figure 2-11 shows 8 height categories (each with a differing number of samples) for the large-bodied birds and 7 height categories for the small bodied birds, but the model only tests 5 heights. How are the remaining data treated?

- Figure 2-11 indicates a complete overlap among the data associated with each of the height categories. Yet, the authors report that the model is significant and the means of some categories are different. How can this be? I would guess that the within-treatment variance is large, and the differences in treatment means would be found insignificant. Is this the sample size phenomena (see above)?

  This is a classic example of the graphics not matching the ANOVA results. I suggest the authors take this ANOVA, and the many others like it, and provide explanations for the ANOVA findings when they are clearly not intuitive. Note that ANOVA models are extremely sensitive to differing sample sizes among treatments. Though there are methods that help overcome this issue, it is not clear that the authors correctly addressed this problem. Frankly, I suspect that the issue lies in the improper treatment of the error structure of the model.

Also note, since the sample sizes are not consistent among treatments, the within-treatment variance cannot be consistently well estimated. So, it is probably unfair to claim that the towers with a height of 43m have a different mean than those that are 25m, when the variance of the 43m treatment is generated with a small number of observations (n=6?) and the variance of the 25m group is generated with a very large number of observations (n>100?). In most environmental surveys, the within treatment variance estimate increases with increasing sample size. Note that sample sizes should always be reported. Again, this illustrates the issues with using hypothesis testing techniques on environmental survey data. It is very easy to misinterpret the statistical results.

11. p. 41, regression model: The regression in Figure 2-11 is misinterpreted and the findings are incorrect. See comments below:

- The reported model r^2 is 0.01. The model has no explanatory power. Therefore, the model does not support a relationship between tower height and carcass location. The authors have misinterpreted the regression outputs. For example, the p values associated with the model itself are a function of sample size (see above discussions), not the explanative ability of the model.

- I believe the authors misinterpret the meaning of the r^2 statistic when they state "Distance from the tower increased with tower height, according to linear regression analysis, although the precision of the model is poor." I do not understand what the authors are addressing when they state "the precision of the model is poor," but I assume it is the r^2 statistic. Again, a model with an r^2 of 0.01 cannot be used to infer a relationship.

- Examination of Figure 2-11 shows that the only reason the reported regression model has any sort of a positive slope is the extensive data collected at towers with mid-level heights. The data at the tallest tower is about the same as that found at the smallest tower. Again, it seems that a misinterpretation of the information has occurred, in part, because the analysis of data was not conducted in a manner that is consistent with the survey design (also see the many comments on sample size above).

- It appears that the error term assumptions of the regression models have not been checked.

12. p. 39, Figure 2-9: This figure does a great job of illustrating my previous points that the data are not normally distributed. Please remove the normal distribution overlay from the figure. Note that the data counts are most probably Poisson distributed. Application of statistical methods using a normality assumption to counts is inappropriate and will generally result in incorrect results and interpretations. Again, I find no discussion of data transformation in the report.

13. p. 43, Figure 2-12: I suggest that the mean and standard error plots be replaced with box-and-whisker plots. The box-and-whisker plots will provide more information and interpretative

ability. Note the ordinates of the Figure 2-12(A) and (B) are different. Does this reflect a difference in the survey design?

Chapter 3. Bird Mortality in the Altamont Pass Wind Resource Area

14. p. 46: It seems that prior studies have expressed mortality in units of deaths per turbine per year. I believe this report is using deaths per MW per year. I recommend that both metrics be presented in the report and interpreted. Reporting mortalities per turbine will allow a direct comparison with prior studies. Also, a comparison among studies can be conducted without the cumbersome use of adjustment factors needed to extrapolate the prior analytic results to the current study.

15. p46: I agree with the authors that a much better approach for assessing the effect of wind turbines on birds is the risk assessment framework. I encourage the authors to adopt this approach in future studies.

16. p. 47: A constant issue in the analysis of survey information is dealing with changes in survey design over time. It seems that the location and number of turbines changed during the course of the study. Also, it seems that the frequency of search times for particular strings changed over time. The authors do not address how the concatenation of data from the various designs could affect the analytical results. I did not find any discussion of normalization approaches for dealing with this issue. These issues are very important and must be addressed in order to provide confidence in the overall report findings.

I am concerned that the standard concept of a sampling unit and a sampling frame have been lost within the survey design. What is the sampling unit? Is it a turbine string? If so, then the analysis should be conducted on data generated on a per string basis. What is the frame - all of Altamont? The authors must discuss the issues related to the representative nature of the survey approach.

17. p. 41 - 52, Searcher detection and scavenger removal rates: It seems that the mortality estimates generated directly from the survey are not trusted. As I understand the discussion, the actual rates have been multiplied by a series of constants prior to reporting the results. The discussion is very confusing, but I think the mortality rates could have been multiplied by at least a factor of 5 prior to publication.

From a statistical perspective, I find this perplexing. If the survey design is properly generated and conducted, there should be little need to adjust for searcher detection error, particularly with a multi-year survey. I can understand scavenger removal rates as an issue, but the results with and without the adjustment should be reported, and a full discussion of uncertainty presented to the reader. From my perspective, these adjustments fall into the broad category of uncertainty, and the results should be clearly displayed so the reader can judge the possible range of mortality estimates.

18. Figures 3-5 to 3-14: I am concerned about the interpretation of the error bars (beyond the issues raised above about the distributional assumptions). Based on the narrative, it seems that some turbine strings are sampled more frequently than others. Therefore, the strings do not

provide an equal amount of information. If this is correct, then the calculation of the error bars should reflect the unequal sampling.

19. Tables 3-3 to 3-8: The ANOVA results presented in these tables suffer from the issues discussed above.

Chapter 4. Impacts To Birds Caused By Wind Energy Generation

20. p. 78: Again, I find that the adjustment factors presented by the authors are not well described. I suspect that the report findings are directly impacted by the adjustment methods described in this section. The authors should report their findings with and without their adjustment methods. As a reader, I can't determine the relative extent to which these approaches influence the findings.

21. p. 78 and Figure 4-1. The first sentence of Section 4.3 reads "Bird mortality correlated significantly with the number of birds observed per hour during point counts." But, the Figure 4-1 caption reads "Mortality estimates for all birds related positively but not significantly." I think this is a contradiction. In any case, the $r^2 = 0.49$ shown in Figure 4-1 is only indicative of a very weak relationship between bird fatalities and birds observed per hour. The authors should be careful to define the terms "significantly." Are they discussing the r^2 value, the null hypothesis that the slope is zero, the overall model test of significance, etc.?

22. p. 79, Figure 4-2: I would agree that an r^2 of 0.70 may be indicative of a relationship between raptor fatalities and birds observed per hour.

23. p. 80: The authors point out that the mortality rate at APWRA is generally higher than other studies. But, the authors do not discuss the role of the adjustment factors in this finding. I am troubled that the somewhat arbitrary use of adjustment factors may be controlling the findings. The authors must provide an uncertainty analysis to show the relative range of mortalities that can be computed both among and within the studies.

24. Figure 4-3: Again, the use of a standard deviation is inappropriate with this data.

25. Note that all of the regression models presented in this section suffer from the statistical shortfalls discussed above (e.g., no testing of error assumptions, no examination of data transformations, etc.). I recommend that the authors simply discuss the findings based on an illustrative graphic rather than using a regression model while trying to make their arguments.

Comments on the LPL Quality Services Audit Report

26. I think the LPL Quality Services audit report points out the need for a strong quality assurance and quality control program within the framework of this report. Proper treatment of the data, and choices made with individual data points, must be obvious to all readers and outside investigators. The report should contain a well written and well documented quality assurance section. Additionally, all data used in the report should be included in an appendix and made available to outside researchers.

27. A review of the LPL Quality Services audit report and associated documentation indicates substantial discrepancies between specific species mortality rates calculated by CalWEA and those reported in the Altamont report. The fact that key bird mortality rate calculations could not be repeated by the auditor is troubling. In particular, the 162% discrepancy associated with the golden eagle suggests a substantial difference in data, methods, or both. The report does not provide a listing of the data used in the calculations, nor does the report explicitly present the equations used in the calculations. The methods and approaches used by CalWEA to calculate mortality rates seem reasonable, particularly since comparable equations were not contained in the original Altamont report.

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October 11, 2006

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Executive Director
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Dear Ms. Rader,

We have completed a review of data used to support the findings contained in *Developing Methods To Reduce Bird Mortality In The Altamont Pass Wind Resource Area*, which was prepared by BioResource Consultants for the California Energy Commission. From your office, we received copies of completed field collection forms used by investigators as they gathered data at the Altamont Pass Wind Resource Area. We also received electronic files created in the SPSS software system. We understand that the SPSS data files were created by BioResource Consultants from the completed field collection forms, and the data were used in the graphics and statistical analyses contained in the Altamont report. Attached is a comparison of the information contained in the SPSS data file and the field collection forms.

Our review found many unexplained inconsistencies between the SPSS data and the field collection forms. This finding may indicate poor data quality control. At the very least, these issues again reinforce the need for a comprehensive and clear data quality assurance and control description within the Altamont report. For example, a review of the field collection forms indicates that 72% of the forms with no indication of a turbine collision were for unknown reasons coded as turbine collisions in the SPSS file. In total, 42% of the field collection forms indicated complete uncertainty as to the cause-of-death, while only 11% of the associated SPSS records indicated uncertainty.

The attached review also finds data quality issues associated with replicate data, possible unexplained changes to the original field forms, inconsistent coding of species type, and translation errors associated with time-to-death values. Any of these issues could have a substantial impact on the findings of the Altamont report. As we have previously noted, the Altamont report did not incorporate uncertainty in the collected field data into the report findings.

We realize that in any ecological survey, investigators must make informed judgements about the field data and investigator notes that appear on the field collection forms. Unfortunately, the Altamont report does not contain a discussion of data quality, nor does the report provide insights into the treatment of data quality and uncertainty issues. For example, protocols for determining if a bird was killed by a turbine collision, even if the field collection form indicated complete uncertainty, were not described. Therefore, impartial reviewers of the report cannot discern the degree to which such decisions influence the overall report findings. Data quality and control issues, like those described in our review, should be clearly described in any scientific report, particularly one in which the report findings are statistically-based.

We suggest that a complete review of all data used in the Altamont report be implemented, including a complete audit of the chain-of-custody procedures used by the investigators. Without a clearly written data quality and data resolution section, the conclusions presented in the Altamont report cannot be critically evaluated. We also encourage the authors and agencies responsible for the report to attach an appendix to the report containing all data upon which the conclusions were drawn.

Sincerely,

[submitted by email]

William Warren-Hicks, Ph.D.
CEO

Altamont Data Review:
A Comparison of Completed Field Collection Forms With Electronic Files

EcoStat, Inc. reviewed data used to support the findings contained in *Developing Methods To Reduce Bird Mortality In The Altamont Pass Wind Resource Area,* which was prepared by BioResource Consultants for the California Energy Commission. From the California Wind Energy Association (CalWEA), we received copies of completed field collection forms used by investigators as they gathered data at the Altamont Pass Wind Resource Area. We also received electronic files created in the SPSS software system (note: CEC data_fatalities.sav contained the mortality data reviewed in this report). We understand that the SPSS data file was created from information on the field collection forms, and the data were used in the graphics and statistical analyses contained in the Altamont report.

We compared the information found on the handwritten field collection forms to the associated information in the SPSS data set. A description of the methods and findings of this review are presented below.

Methods

An electronic SPSS data file and 296 photocopied and completed (handwritten) field collection forms were received from CalWEA. As an organizational aid, EcoStat created an Excel file containing information from each of the 296 field forms. The Excel file, containing all of the critical information found on the completed data collection forms, allowed us to quickly sort the data and scan for closely matched records. The Excel file contained word-for-word comments and notes which were handwritten on the field collection forms. Notes written in the form margins were particularly useful in identifying possible repeat entries. All inconsistencies between the SPSS data set and field collection forms were identified based on the data as received from CalWEA. The Excel file was used as a search tool and organizational aid only.

Table 1 contains a listing of the variables found in the SPSS file and the corresponding data fields available on the field collection forms. The SPSS variable, BRCNUMB, contained a record-specific identification number. This record identification number was handwritten in the margins of most (but not all) of the completed data collection forms. In this report, we refer to the BRCNUMB number as a means of specifying individual records. The SPSS variable ETD contained information on the “Time since death,” a field found on the data collection form. The recorded units of time were inconsistent among the completed data collection forms, but were standardized for days in the coded SPSS variable. The SPSS variable CAUSE is a coded variable corresponding to the “Cause of death” field on the collection form. The SPSS variable REPEAT contained either a “1" or a blank, presumably identifying possible replicate records. Values of the SPSS REPEAT field were compared to handwritten comments on the field collection forms.

Table 1. Variables Found in the SPSS File And Corresponding Data Fields On The Field Collection Form

SPSS Variable Name	Corresponding Data Collection Field
BRCNUMB	Hand written number on top right corner
DATE	"Date"
ETD	"Time since death"
AOU	"AOU code"
SPP2	NA
GROUP	NA
AGE	"Age"
TTYPE	NA
ID	NA
TOWNAME	"Turbine or pole No"
TOWER	"Turbine or pole No"
STRING2	"STR" hand written in "Plot No" field
DISTANCE	"Distance to Structure" units in meters
BEARING	"Bearing"
FINDING	Possibly "Specimen Found", but could not confidently decode
CAUSE	"Cause of death"
REPORT	NA
GENDER	"Sex"
SEX	"Sex"
DIST2	NA
BEAR2	NA
DIST3	NA
BEAR3	NA
INJURY	NA
COMMENT	Notes for "Carcass condition", "Type of injuries", and "Cause of death"
COMMENT2	Notes for "Carcass condition", "Type of injuries", and "Cause of death"
REPEAT	NA
SCAVENGE	NA
INSECTS	NA

NA = Corresponding field was not found on the field collection forms

Some of the SPSS variables contained numeric codes. Categorical variables in SPSS included the following: bird age, sex, specimen found, and cause of death. The SPSS data base contained two comment variables. The COMMENT and COMMENT2 variables summarized information for "Carcass condition", "Type of injuries", and "Cause of death" entries found on the field collection form.

Field collection forms were only available for 270 of the 501 records found in the SPSS data base. Therefore, our analysis was only conducted on a subset of the data base used to support the findings of the Altamont report.

Results

Inconsistencies between the SPSS files and the field collection forms are provided below:

1. Replicate or Missing Records

A listing of replicate or missing data record issues follows:

a. A total of 296 completed and photocopied field collection forms were available for review. Of the 296 forms, 270 contained a unique identification number. One form was not numbered and a corresponding record in the SPSS file could not be identified.

b. Two field collection forms were labeled with the same identification number, 1057. One of the forms had comments indicating that it was part of a previous report. The forms did not contain identical information.

c. An identification number was missing on 24 field collection forms. However, we located 10 identical, and 14 nearly identical, field forms that did have a recorded record identification. A comparison of the 14 nearly identical corresponding field forms showed 10 were indistinguishable, with the exception that "Cause of death" was changed from "unknown" to "turbine collision." The corresponding SPSS records shows cause-of-death as "turbine collision."

   Additionally, one of the 14 field forms was changed from "unknown" to "electrocution." Two field forms had inconsistent AOU entries and one form had extra notes indicating that the findings had not been written up before.

   Examination of the SPSS file indicated that the 24 field forms that were not labeled with an identification number corresponded to BRCNUMB numbers 1220 through 1243.

d. Possible inconsistencies were found between the REPEAT variable in the SPSS data base and information written on the field collection form. A total of 15 records were marked as a replicate in the SPSS data base. Of these, five (BRCNUMB 1010, 1045, 1057, 1061, and 1155) records did not have a corresponding field form in which direct evidence of duplicate information was indicated by the investigator who completed the form.

e. Three field forms contained direct evidence indicating they were possible repeats, but the associated REPEAT variable in the SPSS file was blank (BRCNUMB 1049, 1125, and 1223).

2. Inconsistent Coding of Species Type

Species seem to be identified in the SPSS file by the AOU variable, which contains a four letter code entry for each bird species. A field with this name is found on the field collection form. Inconsistencies generally occurred when AOU on the field collection form is blank or marked "unknown." A listing of these issues follows:

a. On 13 field forms, the AOU field entry was blank or coded as unknown. But, the corresponding records in SPSS were coded as "BIRD" (see BRCNUMB 1097 and 1145, for examples).

b. A total of 20 field collection forms had AOU not marked or marked unknown, but the respective SPSS data base record had an AOU entry that was coded for a specific bird species. Eighteen of these 20 records (BRCNUMB 1008, 1014, 1017, 1026, 1045, 1048, 1055, 1058, 1061, 1067, 1068, 1099, 1116, 1118, 1147, 1151, 1198, 1238) had comments written on the form that could be used to identify the bird species. These comments ranged from very specific species IDs (e.g., BRCNUMB 1008: "Maybe duck or cormorant - feathers are black w/ greenish iridescence") to nonspecific descriptions (e.g., BRCNUMB 1055: "small brown bird").

c. Two SPSS records (BRCNUMB 1059 and 1060) had AOU coded as "passerine" when the field form AOU was not marked and left unknown, respectively. No species identification comments were written on the field collection forms. We note that pictures were taken of both birds.

3. Translation errors between time-of-death and ETD entries

The SPSS variable ETD contains a value for the "time since death" entry found on the field collection forms. The units of time associated with ETD is days. Inconsistency is found in the transformation of time units from the field form to the electronic record. In cases where a range of time was indicated on the field collection form, the median number of days was frequently coded in the SPSS record. For some records, (see BRCNUMB 1014) the conversion to days was accurate to within 24 hours.

Five records had SPSS EDT values that were significantly different from the "Time since death" entries (BRCNUMB 1029, 1133, 1146, 1198, and 1206). For example, BRCNUMB 1029 had a field entry of "3-4 weeks" and an ETD variable of "75 days"; BRCNUMB 1133 had a field entry of "21 days" and an ETD entry of "2 days"). BRCNUMB 1146 and BRCNUMB 1206 had ETD entries of "0" when "Time since death" field was not marked on the field collection forms.

BRCNUMB 1198 field collection form was marked “6 months”, but ETD was left blank in the SPSS data base.

4. Cause-of-death entries were not consistent between field collection forms and the SPSS records

“Cause of death” is a categorical field found on the field collection form. The SPSS data base has a variable CAUSE, with the following seven possible cause-of-death codes:

1 = Collision
2 = Predation
3 = Unknown
4 = Electrocution
5 = Wire strike
6 = Entrapped in turbine
7 = Automobile

A comparison of the field forms with the SPSS records results in the following table. The first column of the table indicates the possible entries on the field forms associated with cause-of-death. Also indicated are combinations of individual entries, denoting when more than one entry was marked on the field collection form. The table is constructed from 270 field forms for which there was a corresponding SPSS record. The 24 replicate field forms (see above) were not counted in the table.

A listing of issues associated with the CAUSE variable follow:

a. With the exception of a single field form (BRCNUMB 1132), all forms with cause-of-death indicated as a turbine collision were given a code of “1" in the SPSS CAUSE variable. The BRCNUMB 1132 field collection form was marked turbine collision, but given a code of “3" in the SPSS data base.

b. Forty-three of the 57 field collection forms (e.g., BRCNUMB 1046 and 1202) where the cause of death was marked as “unknown” (n=38) or “unknown/not enough evidence” (n=5), had a corresponding SPSS CAUSE variable coded as “1=Collision.”

c. Eight of the 10 field collection forms where the cause-of-death was not marked, the corresponding SPSS data base CAUSE variable was given a code of “1=Collision” (BRCNUMB 1008, 1089, 1091, 1146, 1147, 1213, 1214, and 1265).

d. On 30 of the 46 field collection forms where the cause of death was marked as “Not enough evidence”, the corresponding SPSS CAUSE variable was given a code of “1=Collision.”

CAUSE Codes On Field Forms	Number of Field Collection Forms	SPSS Records: CAUSE = Collision	SPSS Records: CAUSE = Unknown	SPSS Records: Other CAUSEs
Turb. collision	146	145	1	0
Unknown	51	38	13	0
Not enough evidence	46	30	16	0
Not marked	10	8	1	1[a]
Unknown/Not enough evidence	6	5	1	0
Turb. collision/Not enough evidence	3	3	0	0
Not marked w/comments	2	0	1	1[b]
Electrocution	2	0	0	2[c]
Predation	2	0	1	1[d]
Predation/Not enough evidence	1	0	0	1[d]
Tower collision/Predation	1	1	0	0
Total Number of entries	**270**	**230**	**34**	**6**

a = SPSS CAUSE variable recorded as "entrapped in turbine"
b = SPSS CAUSE variable recorded as "automobile"
c = SPSS CAUSE variable recorded as "electrocution"
d = SPSS CAUSE variable recorded as "predation"

In total, 72% (0.72 = 81 /113) of the field forms that had cause of death marked as unknown, not marked at all, or not enough evidence were given an SPSS CAUSE variable code of "1=Collision." The SPSS comment variables gave no explanation for this inconsistency. In total, 42% (113 / 270) of the field forms indicated complete uncertainty as to the cause-of-death, while only 11% (31 / 270) of the SPSS records indicated uncertainty.

5. Identification of possible repeat bird findings with closely matched records

This issue involves the identification of possible replicate bird findings, which were scattered over multiple SPSS records. The identification of bird parts on individual field collection forms may indeed be parts of a single bird, but was counted as 2 individual birds.

We searched the SPSS data base in an attempt to identify multiple records, collected in close geographic proximity and time scale, that could have been individual records from the same bird. The “Specimen Found” category on the field collection form was used to identify which bird parts were examined. The “Type” entry field was also used to identify bird body parts. In combination, these entries can be used to identify multiple records possibly representing a single bird. Additionally, the AOU code was used to identify parts belonging to the same species. Other field collection form fields, such as “Date”, “Plot No., “STR”, “Distance to Structure”, “Bearing”, and “Turbine or pole No” were used to identify the location of composite bird parts in suspect reports. Finally, “Time since death” entries were used to identify matched reports recorded on different dates.

Possible repeats were identified in the following paired reports; BRCNUMB 1017/1018, 1074/1118, 1119/1137, 1141/1142, 1178/1179, and 1230/1231. Since there are six possible repeat paired reports, and each pair represents a mortality finding, a total of six possible replicates were identified. We did not check for cases were a single bird could be represented by more than 2 records.

September 18, 2006

Ms. Nancy Rader
Executive Director
California Wind Energy Association

Dear Ms. Rader,

Attached is my review of "Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area" that was prepared by BioResource Consultants. As requested, I focused on the first four chapters of the report and the calculation of mortality estimates. I also considered the review of the Golden Eagle mortality calculation by Pilz & Co., LLC that was sent to me, the accuracy of which I understand has been confirmed by an independent data quality assurance firm.

A summary of the main points of the review are as follows:

1. The report shows evidence of carelessness in preparation. There are instances where the explanations are confusing and there are a number of errors. It is indicative of a report that was prepared too quickly.
2. The statistical analyses that were used were rather simple and it appears that assumptions for some of the analyses were not met. More thought should have been given to analysis and presentation.
3. The careless preparation, the lack of sound statistical design and analysis, and errors in content create a lack of confidence in the conclusions of the report.
4. The differences in the mortality calculations appear to be minor for many species. However, the discrepancy for Golden Eagles is considerable. The calculations by Pilz & Co. appear to be correct for the data they use. I do not have an explanation for the difference other than an error on the part of BioResource or inclusion of data not used by Pilz & Co.

Details and other comments are provided in the attached report.

Thank you for sending the report to me. I hope my comments are informative.

Sincerely,

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Review of "Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area" prepared by BioResource Consultants for the California Energy Commission

The report by BioResource Consultants summarized a four-year research project whose objective was to provide a better understanding of bird mortality at the Altamont Pass Wind Resource Area (APWRA). The focus in this review is on the first four chapters and calculation of mortality estimates.

Overall

The report (sections 1-4) suffers from poor organization and writing as well as a lack of specific details. Most of the problems seem minor however there are a number of inaccuracies that lead to a general lack of confidence in the results from a statistical view.

There does not appear to be a clear study design and the mortality analysis is based on two different studies. When the study design is not connected to the assessment methods and statistical analysis it is not clear if the estimates of important quantities are accurate. For example, page 12 indicates that only 28% of the turbines were initially used. A second set of turbines were used in the second study. It is unlikely these were selected at random and any summary statistics (such as mortality) can only reflect the set of turbines used in a given study and not the entire Altamont Area. Extrapolating mortality estimates from a biased subset to the entire area may be misleading.

It is obvious that a great deal of effort went into the collection of data for the report. It is unfortunate that more time was not spent on improved summarization and description.

It is worth noting that the report alludes to difficulties in obtaining access to certain areas (page 47). This is unfortunate and potentially leads to statistically biased information, especially with regard to mortality estimation.

The authors of the report do indicate potential weaknesses of the study and seem to recognize that the estimates of mortality and comparisons are weak. Especially relevant is the concern for a larger sampling area around a turbine.

While no formula was given in the report for the calculation of the weighted mortality estimate, the formula is likely the same as the one used by Pilz and Co. A more appropriate formula should be considered for future calculations. Most of the discrepancies in calculations appear to be minor although the difference for Golden Eagles is considerable. The two possibilities seem to be either an error in the calculations on the part of BioResource or other samples were included in the calculations.

Other notes and comments

The discussion of the study design is inadequate from a statistical perspective. The report summarizes several studies that focus on different objectives. The report should provide adequate descriptions of each study including information on what is considered a site (string or

turbine), how sites were selected, the number of sites that were used, the hypotheses or parameters of interest, etc. The lack of this information makes it very difficult to assess the validity of the results. It also appears that the study plan changed over the course of the study. While this sometimes happens and may be advantageous, it should be well documented. It is not clear if a pilot study was used as part of the study design. It is possible that the pilot study would have lead to the use of a larger search radius and eliminated the need for a bias correction.

There are a number of errors and inconsistencies in the document that lead to lack of confidence in the results. Some examples include:

> Example 1: On page 1 in the Objectives section, a four-year study is indicated while in the Abstract (page 6, second paragraph) the report suggests a five-year research effort.
>
> Example 2: The number of strings is listed as 380 (page 47) but actually appears to be 280.
>
> Example 3: There are a surprising number of Golden Eagle carcasses found at 50 meters or with an estimated time of death of 90 days (based on the set of data for the 2002-3 sampling period, there were 3 birds found at 50 meters and 2 birds had time of death at 90 days).

The first two are relatively minor and suggest editorial issues. The third is concerning as these birds represent a significant proportion of an important species and could affect calculations.

Adding to the problem is that it is difficult to assess how data were summarized without specific formulas and the formulas that are presented suggest a lack of understanding of the basis of the equations and again do not instill confidence in the results. An example is the discussion of vulnerability on page 9 of the report. The authors define vulnerability due to placement of wind turbines on certain landscape elements as

$$\frac{\chi^2 Observed}{\chi^2 Expected} = \frac{n_i}{Np_i}$$

The above equation is not a standard statistical equation and, if common to the resource usage literature, should be cited. Chi-square analysis is common to resource usage analysis but a valuable metric is the standardized deviation from expectation not the above ratio. Moreover, the ratio is really a ratio of observed and expected assuming random usage of the landscape. It is not necessarily connected to the chi-square value, so I am puzzled why the chi-square part of the equation is included. Also, the subscript is left out of the definition of n_i for flight time (page 10). Although leaving out a subscript may be viewed as minor and not necessarily confusing, it is just one of a number of errors in the document.

A second example concerns the estimation of the mortality factor that is discussed in Appendix A. It is quite common in ecological studies to standardize biological information. Examples include hunting success in deer or duck studies and catch per unit effort in fisheries. Thus, it seems reasonable to adjust mortality to account for detection and to standardize the mortality.

The estimate of mortality is standardized to account for differences in size of turbines/strings and duration of operation. The formula is not presented in the document however Pilz and Co. suggest that it is

$$M_s = \frac{1}{N}\sum_{i=1}^{N}\frac{n_i}{MW_i * d_i}$$

where M_s is the standardized mortality, N is the number of turbine strings studied, n_i is the mortality associated with string i, MW_i is the megawatt output of the string over the duration of the period and d_i is the duration of operation during the study period. A formula that is better adjusts by the sum of the weights rather than the sample size:

$$M_s = \frac{\sum_{i=1}^{N} w_i n_i}{\sum_{i=1}^{N} w_i} = \frac{1}{\sum_{i=1}^{N}\frac{1}{MW_i * d}}\sum_{i=1}^{N}\frac{n_i}{MW_i * d_i}.$$

See Sokal and Rohlf (1995 Biometry, WH Freeman and Co, New York, page 133) for a general discussion. I did not recalculate the estimates and do not have an explanation for why the estimates are so different (from the independent auditors calculations) for golden eagles. It is possible that two birds with an estimated time of death of 90 days were included in the BioResource calculations. If these are included, the estimate becomes 0.089 which is still different by 56%.

In these weighted calculations, the weights play an important role. For the data given in the report, the duration is roughly constant at around 0.5 while there is considerable variation in the megawatts. Strings with low megawatts have a large effect on the estimate, especially with the small sample sizes used in the calculations. For example, for golden eagles, the sum of the estimated deaths per megawatt/duration is 14.88 (using the data from the auditors Excel spreadsheet) and the contribution to that sum is 5.88 from string 328, which is over 1/3 of the value. The string MW is 0.33 for string 328, while other strings have MW values greater than 1.0. Before adopting such a measure, it would seem reasonable to investigate its properties, especially since the approach is not one that has been peer reviewed.

It should be possible (and is recommended) to compute the variance associated with this estimate. I suspect that the variance estimate for the Golden Eagle estimate will be relatively large since the sample size is small and there is one highly influential weight.

Although the report indicates the importance of assumptions in the analysis of data, it is not clear that assumptions were evaluated. The data on distances is evaluated using one of two standard statistical methods: Analysis of Variance and regression analysis. A potential problem is that these methods require valid assumptions for proper inference (specifically normality, homogeneity of variance and independence of observations). The data displayed in Figure 2-11 indicate that the normality assumption is questionable since there are a number of extreme observations. A transformation of distance or a nonparametric analysis should have been used.

When analysis of variance is used, it is common to follow the basic analysis with a comparison of means and evaluation of residuals (as a way to check assumptions). The method used for comparisons of means is the least significant difference (LSD) method which has a tendency to find more differences than other methods such as Tukey's method. There are many methods for multiple comparisons and there should be justification for the method selected. My view is that without justification, the method was selected because it was the default on the computer package that was used or it was used in previous work that was published.

The distance data associated with a particular group (e.g. large-bodied birds) was evaluated for differences associated with several factors (e.g. elevation, season). It is typical for degrees of freedom to sum to the same value for these different factors. For example, for upwind versus downwind the degrees of freedom are 1 and 446 (page 42 top) and for slope grade were 3 and 456. The sums are 447 and 449 suggesting that 448 and 450 observations were used. It is not clear why there are different sample sizes. The analysis of variance is relatively simple and does not include potential interactions between these factors.

A method for displaying means and the variability in the means (standard error or SE) is used throughout the document. However, these figures are deceptive in their interpretation. This type of summary is used in the comparison of means (page 42) yet the standard errors are calculated separately for each group. The analysis of variance uses a common variance estimate. Hence the method does not aid in the interpretation of separation. The displays also do not give an indication of the range of observations. For example, the authors in the discussion of this section point out that 15.3% of carcasses were found outside of the 50-m search radius however this does not appear to be the case from figure 2-12. The reason is that the graph does not display the observations but rather the mean and its variability. Better graphics could have been easily used to convey information associated with either the range of observations or statistical differences in means.

Most of these criticisms on the statistical analysis of the data are minor when taken individually. However, when combined the implication is that not much thought was given to the analysis and presentation of the results. The calculation of the mortality estimates are of concern, especially for Golden Eagles since it is not clear exactly how the calculations were made and which data were used (and what data should be used) in the calculations.

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Quality Assurance Report for the Audit of California Energy Commission Report Entitled Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area Revision 03 Amended

Purpose

The request for audit came from the California Wind Energy Association. The purpose of the audit was to review and verify data, statements and conclusions stated in a report entitled "California Energy Commission Report Entitled Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area" issued August 2004.

Materials Submitted for Audit

Electronic Data

- CEC report
- NREL report
- Spreadsheet containing data used in tables 2 and 3 in the report
- Original source data in SPSS format containing data for facilities and turbine information

Paper Data

- Portions of the report printed and related source documents

Methods

The entire report was not audited. A specific list of items was submitted to LPL Quality Services for audit and verification (See Table 2). In the process of auditing these items other errors were discovered (Table 1).

Due to limitations listed below only the following items could be checked.

1. Statements within the report that referred to tables or figures were verified by looking directly at the figure or checking the number in the table.
2. In some cases the original spreadsheet was available however numbers for mean and standard deviation were not entered as a calculation, just a number so the calculation was recreated.

Limitations

1. The scope of the audit covered portions of chapters 2 and 3 only.
2. Formulas and exact methods used for calculations were not described in the report or provided by the CEC so I was not always able to trace numbers cited in the report.
3. Not all original source data were submitted.
4. Source/input data for figures and graphs was not available. The name and version of software was not always known. It should be noted that opening files with another brand of software could impact data integrity.

5. Statistical analyses containing probability and confidence data were not available.
6. It is not clear if the spreadsheets are the source/original raw data or if data was collected in the field and entered later into the spreadsheets. If this method was used this could be a source of errors that went undetected unless the data had a QC or QA review at the time of entry.

Definitions/Abbreviations
CEC = California Energy Commission
Raw Data or Source Data = the first iteration of the data. In the case of this work it could be data collected on paper in the field including the photographs.

Findings
Tables 1 and 2 list the audit findings.

Table 1 Audit Findings

CEC Report Reference	Observation	QA Comment
1. Section 2.2 Methods, para. 1	An assumption was made that any birds with injuries would die therefore they were classified as a carcass.	This statement introduces bias into the study.
2. Section 2.3.1 Overview of Bird Fatalities in the APWRA, para. 3	They cite total fatalities from Wind Turbine Collision as 1162 from table 2-1.	The total in the table is actually 1160.
3. Section 2.3.1 Overview of Bird Fatalities in the APWRA, para. 3	Using table 2-1 as a reference they cite 2 carcasses from auto collision and 13 due to predation.	These are not listed in table 2-1.
4. Section 2.3.1 Overview of Bird Fatalities in the APWRA, Figure 2-1	This chart doesn't agree with table 2-1.	This finding should be researched further.
5. Figures 2-2, 2-3	Source data not supplied – unable to verify.	None
6. Table 2-1	Fatalities column total is incorrect. Wind turbine collision total is incorrect. When table 2-1 is compared to table 3-1 there are discrepancies. Example: Buteo sp. T2-1 =	Should be 1188 not 1189. Should be 1160 not 1162.

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CEC Report Reference	Observation	QA Comment
	24, T3-1 = 23.	
7. Section 3.2 Methods, para. 1	Search dates for the second set of turbines is stated as November 2002 – May 2003.	Checking the source data it appears that the correct dates should be October – April.
8. NA	It appears that no histopathology was performed in any of the carcasses.	Without necropsies it seems that an objective cause of death cannot be determined in all cases.

Conclusions

The audit of this report was by no means comprehensive since the scope included a limited data set. However, within the limited scope of the audit, findings included several simple errors that were found in the text and tables of the report as well as the spreadsheets submitted. Examples of the errors included the number of types of birds, turbines, search dates, and areas searched. There were inconsistencies from table to table within the report. In some cases several methods were applied to try to reconstruct calculations used to verify ratios and other numbers used in the report without success.

Also methods used by the company that performed the study included several 'assumptions' which seem to make parts of the data collected 'qualitative' instead of 'quantitative'. These assumptions could introduce bias in the data which could have lead to inaccurate conclusions drawn.

These errors lead the auditor to conclude that there are issues with data quality and integrity in this report. The recommendation is that a full audit of the source data and analyses used to write this report should be performed to ensure that the statements made and the conclusions drawn are accurate.

Note: This report was amended October 23, 2006 to clarify a couple of sentences that may not have been clear in the original report. The reference to the AQL was removed at the request of Cal WEA because it was thought to be an inappropriate reference. Also Table 2 Question 8 – wording was added to clarify how the numbers presented in the CEC report were verified.

Submitted by: _____ Date: October 23, 2006
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Table 2 Requested Items for Audit from CalWEA

CEC Report Reference	CEC Documentation	CalWEA Questions	QA Comment
1. Section 3.1 Introduction, para. 1	NA	The report states that mortality can be used as an impact estimate to decide the extent, magnitude and types of mitigation that should be implemented in the APWRA. Are the mortality estimates in the report sufficiently accurate for this use?	I cannot conclude that. See comments in the Conclusions section above.
2. Section 3.2 Methods, para. 1	CEC data_turbine attributes.sav; CEC data search_dates.xls	1. Is the cited number of 2,548 turbines in the second set of turbines searched correct? 2. Is the cited number of 380 strings in the second set of turbines searched correct? 3. Is the cited span of searches from November 2002 until May 2003 for the second set of turbines searched correct?	1. The number of turbines is correct. 2. No. Number of strings stated as 380 should be 281. 3. No. The date span is stated as Nov, 2002 – May 2003 in the report. The data provided has dates from October, 2002 –April, 2003.
3. NA	CEC data_turibine attributes.sav; CEC data search_dates.xls	Do the turbine IDs and number of turbines in the strings match between the two files?	No. A select number of Turbine IDs were audited and several were found to be incorrect or missing.
4. Table 3-10 footnote b	CEC data_turbine attributes.sav	Is the cited number of 267.090 MW in the second set of turbines searched correct?	No. It does not appear to be correct. The MW should be 281.12.

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CEC Report Reference	CEC Documentation	CalWEA Questions	QA Comment
5. Section 3.2 Methods, para. 11	CEC data search_dates.xls	1. The report states that the scavenger removal factors were from a study in which a number of carcasses were placed in the field and the percent remaining after 40 days was determined. Is it correct to use this directly for a scavenging correction when it implies all carcasses are from birds that died on the first day of the interval between searches rather than throughout the interval?	1. No. I think logic tells you that you can't make the assumption that all the animals died on the first day. Using this premise would introduce bias into the study, possibly falsely increasing the number.
		2. The report states that non-raptor scavenging removal rates were halved and used for the raptor scavenging removal rates. Does this calculation produce the small- and large-raptor scavenging rates they cite?	2. No. I could not reproduce this number. It appears that they doubled the rate of the remaining carcasses instead.
		3. Is the cited number of 90 days as the average between searches in the second turbine set correct?	3. No. When the CEC data_search dates file was reviewed the number that I get is 99.1 +/- 10.9 days.

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CEC Report Reference	CEC Documentation	CalWEA Questions	QA Comment
6. Section 3.2 Methods, para. 7; Section 3.3 Results para. 1	NA	1. Is there a gap in the range used to define "old" vs. "fresh" birds?	1. The CEC report defines 'fresh' as <90 days old (p.48) and 'old' as >90 days. The NREL report defines 'fresh' as <60 days old (p.39). Could not find how birds at 90 days old are categorized.
7. Section 3.3 Results, para. 1	NA	1. Page 52, section 3.3 states that the number of carcasses that were greater than 90 days old is 198. Is this correct?	No. Referencing table 3-1 type A (old and fresh) = 1162. Type B (fresh) = 923. Type A – Type B = >90 days old. 1162 – 923 = 239. Therefore 198 is incorrect. Note: The 1162 number should be 1160 and the 923 number should be 922. Even with this correction the number is still 238 which does not match 198 as stated in the report.
8. Table 3-9	CEC data_turbine attributes.sav; CEC data_search dates.xls; CEC data_fatlities.sav	1. Is it possible to reproduce the calculated factor for golden eagle and red-tailed hawk uncorrected set 2 mortality? 2. There is a set 2 mortality factor listed for great-horned owls. Is there a set 2 great-horned owl with an assigned ETD (estimated time	1. No. I can't reproduce the mortality numbers in the report. 2. Ref. Table 3-9 Checked for GHOW for set 2. There are none.

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CEC Report Reference	CEC Documentation	CalWEA Questions	QA Comment
		since death) less than 90 days? 3. Is it proper to present a standard error of the mean when the mean is derived from only one carcass, as was presented for the set 2 uncorrected mallard, common raven, brown-headed cowbird and loggerhead shrike mortality? 4. Of the data submitted to verify mortality factors for 17 species in table 3-9 how many were reproducible?	3. No. This is incorrect since the statistic can't be calculated with an N=1. 4. Using raw data from the CEC SPSS file only 6 of the mortality factors were reproducible. The Cal WEA reference file used was titled "Mortality revised.xls". Calculations in this file were verified. Mortality factors for the Golden Eagle appear to be grossly over stated by 162%. Others such as the Mourning dove (18%), and Red-tailed hawk (23%) were moderately over-estimated.
9. Table 3-11	NA	Do the reported "all raptors" and "all birds" search detection and scavenging-adjusted deaths per year correspond to the sum of the adjusted deaths per year for individual species of raptors and	Not clear how the calculations were performed in table 3-11. The adjusted mortalities/yr for all birds and all raptors are higher than those stated in table 3-1.

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CEC Report Reference	CEC Documentation	CalWEA Questions	QA Comment
		birds?	
10. Section 3.2 Methods, para. 2	CEC data_search dates.xls	Is the cited number of 7.2 for the average number of searches per year correct?	No. The average number of searches (set 1 and 2 combined) per year is stated as 7.2. It is incorrect because it appears that the incorrect number of strings for set 2 (380 – see item 2 above) and the average search interval (90 days – see item 5 above) were used to perform the calculation. If the correct number of strings is 281 and the correct number for average search interval 99 days are used then the average number of searches for set two would change to 4.7. This would change the overall average number of searches (set 1 and 2 combined) to 5.9 per year.
11. Figures 3-1 and 3-2	CEC data_search dates.xls	Do these figures accurately reflect the set 2 turbine search intervals?	No. If the calculation in item 2, QA Comment 2 above, is not correct then this graph would not be correct.
12. Section 3.2 Methods, para. 1	Exhibit A of the December 20, 2001 Standard Agreement between the CEC and BioResource Consultants	Is the statement that access to the second set of wind turbines was not granted until only six months remained in the study correct?	No. The contract signed with the CEC states that they had access as of December 2001.

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CEC Report Reference	CEC Documentation	CalWEA Questions	QA Comment
12. Section 3.4 Discussion, para. 1	Exhibit A of the December 20, 2001 Standard Agreement between the CEC and BioResource Consultants	Is the statement that access to the second set of 2,548 wind turbines was not gained until late in 2002 correct?	No. The contract signed with the CEC states that they had access as of December 2001.
13. NA	NA	Does the audited data set indicate sufficient accuracy in data handling and fidelity in data reporting for the study to be relied upon in wind park litigation, policy making or legislation?	No. The data audited here was only a small subset of all the data gathered and represented in the report.

CALWEA APPENDIX TO LPLQS AUDIT REPORT
CalWEA Mortality Calculations Verified by LPLQS
(See Table 2, CEC Report Reference 8, QA Comment 4)

The LPLQS audit verified the mortality factors calculated by CalWEA in reference file "Mortality revised.xls." Table A shows the mortality factors for all species as reported for Set 2 turbines versus the factors calculated by CalWEA based on the report data. Table B provides, as an example, the golden eagle mortality factor calculation. All electronic files are available upon request.

CalWEA Mortality Factor Calculation

$$\sum^{no.\ of\ carcasses} \frac{1/\ string\ MWs\ /\ fraction\ of\ yr}{no.of\ strings}$$

where,

string MWs = the MWs generated during the search period by the searched strings
fraction of yr = the period of time (as a fraction of a single year) the search was conducted
no. of strings = the number of strings searched in Set 2

Note: a string is a row of turbines closely spaced.

Data sources
Number of carcasses & string ID – *CEC data_fatalities.sav* (SPSS file)
String MW and search duration – *mortality per MW and per turbine.sav* (SPSS file)

A. Mortality factors in Set 2 turbines, report vs. calculated factors

Species	Factor from data (d/MW/year)	Factor from report (d/MW/year)	Difference (%)
American kestrel	0.1217	0.1251	2.8
Barn owl	0.0284	0.0292	3.0
Brown headed cowbird	0.0227	0.0227	
Brewer's blackbird	0.0441	0.0500	13
Burrowing owl	0.1000	0.1000	
Common raven	0.0091	0.0091	
European starling	0.1220	0.1353	11
Ferruginous hawk	0.0348	0.0348	
Golden eagle	0.0532	0.1391	162
Loggerhead shrike	0.0131	0.0131	
Mallard	0.0119	0.0119	
Mountain bluebird	0.0170	0.0172	1.1
Mourning dove	0.0188	0.0222	18
Northern flicker	0.0194	0.0197	1.7
Rock dove	0.1051	0.1132	7.7
Red-tailed hawk	0.2025	0.2490	23
Western meadowlark	0.2046	0.1975	-3.4
Great horned owl	0[a]	0.0040	na

a - There was no great horned owl carcass in the data file meeting the criteria for calculation of a mortality factor

B. Example: Golden eagle calculation

Carcasses	String ID	String MW	Duration (year)	String d/MW/y	Sum string d/MW/y	Set 2 factor d/MW/y
1	312	5.200	0.525000	0.366300	14.8881	0.0532
1	319	1.100	0.525000	1.73160		
1	328	0.300	0.566667	5.88235		
1	331	3.100	0.566667	0.569260		
2	335	2.800	0.566667	1.26050		
1	340	1.400	0.566667	1.26050		
1	361	2.300	0.558333	0.778716		
1	363	1.100	0.541667	1.67832		
1	408	1.400	0.525000	1.36054		