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STATE OF CALIFORNIA

Energy Resources Conservation and Development Commission

In the Matter of: APPLICATION FOR CERTIFICATION FOR THE PALEN SOLAR ENERGY GENERATING SYSTEM	DOCKET NO. 09-AFC-7C

INTERVENOR CENTER FOR BIOLOGICAL DIVERSITY

Exhibit 3140

Corrections to Opening Testimony of K. Shawn Smallwood, Ph.D.

Scope of Corrections

I am submitting these Corrections to my opening testimony (Exhibit 3128) because: 1) my opening testimony inadvertently utilized the acreage of 4,024 acres for the permitted solar thermal trough project rather than 3,794 acres of disturbance (of which 3,547 is solar fields) in the FSA for the proposed amendment; and 2) to clarify my references to the RSA (which formed the background for the Staff's FSA provided for the proposed amendment to change from the permitted trough design to two power towers). As stated in my opening testimony, I reviewed both the FSA and RSA.

Summary of Testimony

The Palen Solar Electric Generating System ("Palen") as amended would destroy at least 3,794 acres[1] of wildlife habitat and would put in its place thousands of heliostat mirrors and two power towers that will kill flying birds. I reviewed the Revised Staff Assessment (RSA) for the trough project, Final Staff Assessment (FSA) for the proposed amendment, and related documents to assess project impacts, mostly as they are caused by collisions and thermal injuries to birds. I determined that, given the fatality rates reported for Solar One and given the numbers of fatalities being found at Ivanpah, the fatality rates that would be caused at Palen could far exceed the fatality rates in the Altamont Pass Wind Resource Area, even though the 500 MW of installed capacity at Palen would be smaller than the 580 MW capacity of wind turbines in the Altamont Pass. The numbers of fatalities coming from Ivanpah reports suggest that avian fatality rates could exceed 20,000 per year. Curtailment and avian deterrent strategies have been proposed as mitigation measures as part of adaptive management at Palen, but these strategies

[1] FSA at 3-1, 4.9-12 ("Solar fields (3576 acres) + Common Area (15 acres) + Laydown Area (203 acres) = 3794 acres (Does not include offsite linear facilities.)").

have no record of success and probably would not yield measureable reductions in fatalities. The avian deterrent strategies might increase bird fatalities by scaring birds into heliostat mirrors. I also recommended monitoring methods and mitigation measures to minimize project impacts from Palen, if approved and constructed, and to learn from the impacts so that mistakes are not repeated.

Qualifications

My qualifications for preparing expert comments are the following. I earned a Ph.D. degree in Ecology from the University of California at Davis in 1990, where I subsequently worked for four years as a post-graduate researcher in the Department of Agronomy and Range Sciences. My research has been on animal density and distribution, habitat selection, habitat restoration, interactions between wildlife and human infrastructure and activities, conservation of rare and endangered species, and on the ecology of invading species. I have authored numerous papers on special-status species issues, including "Using the best scientific data for endangered species conservation," published in Environmental Management (Smallwood et al. 1999), and "Suggested standards for science applied to conservation issues" published in the Transactions of the Western Section of The Wildlife Society (Smallwood et al. 2001). I served as Chair of the Conservation Affairs Committee for The Wildlife Society – Western Section. I am a member of The Wildlife Society and the Raptor Research Foundation, and I've been a part-time lecturer at California State University, Sacramento. I was also Associate Editor of wildlife biology's premier scientific journal, The Journal of Wildlife Management, as well as of Biological Conservation, and I was on the Editorial Board of Environmental Management.

I have performed avian surveys in California for twenty-four years (Smallwood et al. 1996, Smallwood and Nakamoto 2009). Over these years, I studied the impacts of human activities and human infrastructure on birds and other animals, including on Swainson's hawks, burrowing owls, and other species. I studied fossorial animals (i.e., animals that burrow into soil, where they live much of their lives), including pocket gophers, ground squirrels, kangaroo rats, voles, harvester ants, and many other functionally similar groups. I performed focused studies of how wildlife interact with agricultural fields and associated cultural practices, especially with alfalfa production. I have also performed wildlife surveys at many proposed project sites, including at a proposed large solar thermal project in the Mojave Desert. Finally, I have performed research and monitoring on renewable energy projects for fifteen years, and I have authored many peer-reviewed report, papers, and book chapters on fatality monitoring, fatality rate estimation, mitigation, and other issues related to biological impacts of renewable energy generation. I have also reviewed many reports, served for five years on the Alameda County Scientific Review Committee that was charged with overseeing the fatality monitoring and mitigation measures in the Altamont Pass Wind Resource Area, and prepared many comment letters on proposed renewable energy projects. I also collaborate with colleagues worldwide on the underlying science and policy issues.

My CV is attached.

IMPACT ASSESSMENT

Alternatives

I concur with CEC Staff that the Reduced Acreage Alternative would have the lowest level of direct, indirect, and cumulative impacts compared to the Proposed Project or to the other "build" alternatives; however, impacts to avian species could be substantially avoided under a distributed solar alternative which was not fully addressed in the RSA or FSA. The Reduced Acreage Alternative would be even more effective at minimizing project impacts if it was carefully sited to avoid areas most often used by flying birds that exhibit behaviors likely to result in collisions with heliostat mirrors or the zone of solar flux.

Special-status species

I disagree with CEC Staff that Impact Avoidance and Best-Management Practices (BIO-8; FSA 4.2-264-271), Pre-construction Nest Surveys (BIO-15; FSA 4.2-287-288), and the Avian Enhancement and Conservation Plan (BIO-16a; FSA 4.2-289-292) or the Avian and Bat Protection Plan (BIO-16b; FSA 4.2-292-296)) will "avoid" impacts to migratory birds. These strategies would do no better than to minimize impacts. To avoid the impacts, the project would not go forward. It would be impossible for the proposed project or any of the alternatives evaluated in the FSA to be constructed in a manner to avoid impacts to birds. The use of power pole retrofits in BIO-16a could provide some mitigation, however I am concerned that it is not additive mitigation as the utilities or other owners of the power poles already have an obligation to minimize impacts from those features on avian species.

I also disagree that BIO-17 (FSA at 298-305) would avoid project impacts to kit fox and American badger. Again, mitigation might minimize impacts, but avoiding impacts to these species would be impossible if the project goes forward. American badgers will likely be crushed by construction operations, and both the badger and kit fox would lose 3,794 acres of habitat.

Under "Summary of Impacts" beginning on page C.2-68 of the RSA (which analysis was not changed by Staff in the FSA), CEC Staff used percentages of habitat loss within the NECO planning area. These percentages can be misleading because they treat all acres as equivalent within the NECO planning area. Each species will uniquely use the landscape, targeting certain parts of it. For example, CEC Staff concluded that Palen would reduce burrowing owl habitat within the NECO planning area by 0.9%, but the basis of that percentage was 339,704 acres of planning area. In my experience, only a fraction of any region is usable by burrowing owls or any other species. For example, in hilly environments, the majority of burrowing owl nests are located at the zone of transition between valley bottom and slopes (Smallwood et al. 2009b). If 10% of the burrowing owl population happened to rely on the footprint of the Palen project, then the impact would be more than 10 times greater than claimed by CEC Staff.

Collision risk

In the FSA staff concluded that the risk of collisions was "similar" to the trough project.[2] According to the FSA *"There is uncertainty regarding how many birds may be killed by collisions with project features, but bird mortality is expected. The significance of such mortality, in a CEQA context, is uncertain, and would vary depending on the number and species involved"* (FSA at 4.2 -154).

It is true that it remains unknown to what degree fatality rates might differ from those measured at Solar One (McCrary et al. 1986), which was the first concentrating thermal power plant in California and the only such plant for which the results of scientific monitoring have been published. Fatality monitoring methods have improved since McCrary et al. (1986), and only one year of monitoring was performed at Solar One, which was also only 10 MW in size. Nevertheless, in the face of high uncertainty when assessing impacts to rare environmental resources, the accepted standard is to err on the side of caution (National Research Council 1986, Shrader-Frechette and McCoy 1992, O'Brien 2000). CEC Staff's conclusion would err on the wrong side of caution.

McCrary et al. (1986) remains the only published study of direct impacts to birds caused by a solar power plant (Solar One). McCrary et al. (1986) searched for dead birds amongst the heliostat mirrors and around the power tower, and they estimated a bird fatality rate caused by bird collisions with heliostat mirrors and the power tower, and by heat encountered when birds flew through the concentrated sunlight reflected toward the power tower. However, McCrary et al. (1986) appeared to have under-appreciated the magnitude of the impacts caused by Solar One, likely because McCrary et al. (1986) did not know as much as scientists know today about scavenger removal rates and searcher detection error.

McCrary et al. (1986) searched for dead birds during 40 visits to the 10 MW Solar One Project. Their search pattern was not fixed, so it was not as rigorous as modern searches at wind energy projects and other energy generation and transmission facilities. McCrary et al. (1986) placed 19 bird carcasses to estimate the proportion remaining over the average time span between their visits to the project site, though they provided few details about their scavenger removal trial. We know today that the results of removal trials can vary substantially for many reasons, including the species used, time since death, and the number of carcasses placed in one place at one time, and etc. (Smallwood 2007). McCrary et al. (1986) also performed no searcher detection trials, because they concluded that the ground was sufficiently exposed that all available bird carcasses would have been found. This conclusion would not be accepted today, based on modern fatality search protocols.

Because, scientists have performed many more scavenger removal trials and searcher detection trials, as well as many more bird carcass searches since the study of McCrary et al. (1986), I re-calculated the fatality rate estimate from that first study, but this time using national averages to represent scavenger removal rates and searcher detection rates (see Smallwood 2007, 2013). Based on the methods in Smallwood (2007), I have since reviewed more than 400 searcher

[2] FSA at 6.1-31

detection trials and more than 400 scavenger removal trials across North America (Smallwood 2013). From these reviews, I estimated the average proportion of carcasses remaining after 9 days since the last carcass search. I used 9 days for the average search interval, because that was the average search interval in the McCrary et al. (1986) study.

The estimator I used was derived from Horvitz and Thompson (1952):

$$\mathrm{F_A} = \frac{\mathrm{F_U}}{\mathrm{R_C} \times \mathrm{p}},$$

where F_U was the unadjusted number of fatalities/MW/year (the found carcasses), and F_A was the fatality rate adjusted for the proportion of carcasses found amongst those that were available to be found, *p*, and by the average proportion of carcasses remaining since the last fatality search, R_C. The adjustments for *p* and R_C were estimated from searcher detection trials and scavenger removal trials. I assumed carcasses were deposited at a steady rate from heliostat mirrors and power towers, so I took the average proportion of carcasses remaining each sequential day between searches:

$$\mathrm{R_C} = \frac{\sum_{i=1}^{I} \mathrm{R_i}}{\mathrm{I}},$$

where R_i was proportion of carcasses remaining by the *i*th day following the initiation of a scavenger removal trial. Thus, the expected proportion of carcasses remaining by the next fatality search should be R_C corresponding with the fatality search interval, *I*, which was 9 days in the McCrary et al. (1986) study. Note that McCrary et al. (1986) used R_i instead of R_C, which means their fatality rate estimate would have been inflated for this factor alone (their estimate was biased low, however, by assuming they experienced no searcher detection error).

McCrary et al. (1986) reported the mean and standard deviation (SD) of bird carcasses found per visit, but estimating rates for the purpose of extrapolation should include a standard error (SE), which can be approximated as:

$$SE = \frac{SD}{\sqrt{n}},$$

and which, in the case of McCrary et al. (1986), with a SD = 1.8 and n = 40 visits, was 0.28 (the calculated mean was 1.75).

Using SE also facilitates carrying of the error terms through the calculation of the fatality rate estimate. For this purpose, I estimated standard error of the adjusted fatality rate, $SE[F_A]$, using the delta method (Goodman 1960):

$$SE[F_A] = \sqrt{\left(\frac{1}{p \times R_C} \times SE[F_U]\right)^2 + \left(\frac{F_U}{p} \times \frac{-1}{R_C{}^2} \times SE[R_C]\right)^2 + \left(\frac{F_U}{R_C} \times \frac{-1}{p^2} \times SE[p]\right)^2}.$$

Using data reported by McCrary et al. (1986), and adopting their assumptions, their estimated fatality rate was 1.75 fatalities/visit divided by 70% to 90% of placed trial carcasses remaining between visits, or 1.75 ÷ 0.90 = 1.94 and 1.75 ÷ 0.70 = 2.5. Assuming a point estimate of 80% of placed carcasses remaining, then the estimated bird carcasses per visit would be 1.75 ÷ 0.80 = 2.19. Given that there were 40 visits in the year, then 2.19 × 40 = 87.6 bird fatalities per year, or on a per-MW basis, there were 87.6 fatalities/10 MW = 8.76 bird fatalities per MW per year. Because McCrary et al. (1986) did not report the SE of their proportion of placed trials carcasses remaining, and because they assumed $p = 1$, I could not carry the error terms, so the estimate from their study was 8.76 bird fatalities/MW/year with an 80% confidence interval (CI) of 6.96 to 10.55. The only real challenge remaining is to extrapolate this estimate to the 500 MW Palen Solar Project.

I predict that if the entire project was searched periodically for fatalities at a 9-day interval, then 4,375 bird fatalities would be found per year (80% CI: 3,480 to 5,275). However, these rates need to be adjusted for the proportion of fatalities not found by searchers. The results of my adjustment trials yielded national averages of $R_C = 0.48$ (SE = 0.12) for birds over a mean search interval of 9 days and $p = 0.676$ (SE = 0.029) when ground visibility was characterized as high or very high. Using these values, my estimated fatality rate at McCrary et al.'s project site was 21.57 fatalities/MW/year (80% CI: 7.15 to 36.00). Relying on these adjustments and extending them to the 500 MW size of Palen, then I predict that Palen will kill 10,787 birds per year (80% CI: 3,573 to 18,000). These fatality rates would equal or exceed the fatalities estimated at the Altamont Pass Wind Resource Area, which has become infamous worldwide as the most dangerous wind project in the world.

Are these fatality rates supportable? They come directly from the rates reported from the only published results of scientific monitoring at a solar thermal project. This project – Solar One – was not too distant from Palen, so should be relatively similar in bird species composition. The technology was very similar, consisting of a power tower receiving reflected light from heliostat mirrors. Another solar thermal project with power towers was the Ivanpah Solar Electric Generating Station. I had predicted fatality rates there, too, using the same calculations I detailed herein, but applied to the planned 370 MW capacity of Ivanpah. I had predicted 7,981 bird fatalities/year (80% CI: 2,646 to 13,320). Fatality monitoring data coming out of the Ivanpah project, now that it has been built, have been difficult for me to interpret because I have been unable to determine for certain how the monitoring was performed, but the large numbers of birds found per month indicate that fatality rates have been very high.

Document TN 200642_20130930TO090221 included 70 avian fatalities found at Ivanpah. Seventy fatalities was the same number found at Solar One after a year of monitoring, but the Ivanpah fatalities were mostly incidental and did not appear to have come from a scientific monitoring program. The implication of so many incidental fatality records was that fatality rates were very high.

Scientific monitoring appears to have been completed in April and May 2014 (TN202368 _20140522T141156_ISEGS_Monthly_Compliance_Report_43_April_2014 and TN202461_ 20140616T145736_ISEGS_Monthly_Compliance _Report_No_44__May_2014). The April searches turned up 101 fatalities and the May searches discovered another 82 fatalities. If the searches were performed according to document TB201315, which summarized a monitoring plan for Ivanpah, then weekly searches were performed at 20% of the heliostat mirrors at Ivanpah during April and May 2014. Given the size range of the birds found, including many hummingbirds, swallows and warblers, I would predict that the overall adjustment rate for searcher detection and carcass persistence would be no greater than 20%. That means the number of fatalities found would be divided by 0.2 to arrive at an adjusted estimate of 473 fatalities per month within the search areas. This number then would be divided by 0.2 (corresponding with 20% of the project being searched) to extrapolate the fatality estimate to the rest of Ivanpah, yielding 2,365 birds per month during April and May 2014. If this rate persisted yearlong, then Ivanpah might be killing 28,380 birds, which would be 3.6 times greater than the fatality rate I predicted.

The calculations I just made of fatality rates at Ivanpah were back-of-the-napkin-level, and were based on assumptions that I cannot at this time verify as correct. If I was even close to correct, however, then I suggest that the CEC take a harder look at the potential impacts of Palen. If Ivanpah is killing as many birds as my quick calculations and my unverified assumptions suggest, then solar thermal in California's deserts will cause far greater impacts to wildlife than did the notorious Altamont Pass Wind Resource Area.

The two four-acre evaporative ponds would likely increase the fatality rates at Palen. These ponds might attract birds, which would then come into proximity of the heliostat mirrors and the zone of solar flux.

Clearly, the McCrary et al. (1986) fatality monitoring study resulted in a highly uncertain fatality rate estimate, which was revealed to be even more uncertain when considering national averages of the adjustment factors and when carrying the error terms through the calculations. The direct impact of Palen can be said to be highly uncertain at this point. It would be helpful to perform avian behavior surveys in advance of any approval, in order to characterize avian flight paths and the types of behaviors of endemic species that could contribute to collision risk (Smallwood et al. 2009, 2010). If the project goes forward, it would be very important to require sound fatality monitoring. In designing pre- and post-construction monitoring, it should also be kept in mind that 70% of the bird fatalities at Solar One were caused by collisions with the heliostat mirrors and 30% were killed by solar flux between the mirrors and the power tower.

Wildlife Movement

CEC Staff focused on wildlife use of desert washes and ephemeral drainages as the sole portions of the landscape where wildlife move. In my experience, and I have a lot of experience recording the travel paths of wildlife, there has been little solid evidence that wildlife use linear features of the landscape, such as washes and drainages, any more than they use upland areas. Wildlife movements are not restricted to washes and drainages; if they were so constrained, then their movements would be too predictable and predators and competitors would too easily exploit these movement constraints.

The Palen project will disrupt the movement of non-volant wildlife in the region. The site will be fenced and the interior will lack a full complement of natural cover. The obvious conclusion should be that the project will disrupt movement of a large number of species.

Cumulative Effects

I agree with CEC Staff conclusions in the FSA regarding cumulative effects (FSA at 4.2-9 – 10). I will add that the impacts of the Ivanpah Solar Electric Generating System include annually thousands of birds killed by heliostat mirrors and solar flux, just as will occur at Palen. My predicted impacts for both of these combined projects would be 18,768 bird fatalities per year (80% CI: 6,219 to 31,320). If the monitoring data at Ivanpah continue to support my calculations (see above), then the combined projects would cause >50,000 bird fatalities per year.

MITIGATION MEASURES

Designated Biological Monitor

The impacts caused by Palen if permitted and constructed will be larger and more complex than can be reasonably expected to be handled by a designated biological monitor and CEC compliance monitor. A Technical Advisory Committee (TAC) should be established, and the TAC members should be composed of experts on scientific monitoring and mitigation. The TAC should not be composed of members of regulatory agencies, unless those individuals are expert in scientific monitoring and have demonstrated records of success in testing the efficacy of mitigation plans. The TAC meetings, documents, and activities should be fully transparent to the public including being publicly noticed and accessible and provide an opportunity for public input.

Pre-construction Surveys to Predict and Mitigate Impacts

Other than one utilization survey effort in Fall 2014, I did not see any description of pre-construction bird and bat surveys to predict collision rates with heliostat mirrors in the RSA or FSA, to guide the siting of the facilities to minimize collision risks, or to serve as a baseline against which to measure displacement or attraction impacts after construction. The one bird count survey in Fall 2013 (TN 202002; Levenstein et al. (2014)) covered only a single season of one year – Fall 2013. According to Levenstein et al. (2014), "*The principal objectives of the fall studies were to: 1) provide site-specific fall bird resource and use data that would be useful in evaluating potential impacts from the proposed concentrated solar energy facility; 2) provide information that could be used in project planning and design of the facility to minimize impacts to birds, and 3) recommend further studies or potential mitigation measures, if warranted*." Levenstein et al. (2014) reported species richness, mean use (birds/hour) and each species' percent composition of the 185 bird species detected. However, Levenstein et al. made no attempt to account for the influence of bird size or distance from the observer when comparing detection rates or percent composition, so the reported results cannot be interpreted accurately. Whereas turkey vultures can be seen all the way out to the 1,000 meter maximum survey radius, tree swallows would not have been identified to species beyond about 100 meters from the observer. Given these profound biases, comparisons of mean use or percent composition were meaningless.

Levenstein et al. (2014) showed more promise when comparing birds per hour by time of day and by height above ground, because information about these variables could inform a curtailment strategy. Unfortunately, the observations were lumped by multiple species per group, such as "raptors," Buteos," and "Accipiters." Each species is unique, with unique natural histories and activity patterns. Lumping species into larger taxonomic groups will cloud understanding of how birds are actually using the airspace over the proposed project. I saw no value in the results presented on time of day or flight height, because they cannot help me decide whether or how curtailment or any other mitigation strategy should be implemented.

Levenstein et al. (2014) provided a seasonal analysis, which seemed absurd because the surveys only covered one season. Nothing could be said of bird activity over winter, spring, or summer.

A crude spatial analysis was attempted, but only mean use rates were compared. To be meaningful, mean use rates would need to be accompanied by estimates of variation, such as standard error or confidence ranges. When Levenstein et al. (2014) reported that mean use was greater at one or two of the observation stations, I have no way of knowing whether the report was true because the reporting lacked confidence ranges.

More important than the shortfalls in reporting the data, Levenstein et al. (2014) failed to achieve any of their stated objectives. They made no fatality predictions (obj. 1). They made no recommendations on project planning or design to minimize bird fatalities (obj. 2). They offered no recommendations on mitigation measures or on further studies (obj. 3). Levenstein et al. (2014) did not report what they initially promised. Furthermore, I have seen no evidence in any of the applicant or CEC staff documents that demonstrate that the plan for the Palen project was changed one little bit as a result of the Fall 2014 utilization surveys. I could see no real value in the surveys that were performed.

The following is what I propose should be done to establish a proper baseline for predicting and measuring project impacts on volant wildlife.

A full year of behavior surveys prior to project development and approval should provide sufficient information to predict impacts (Smallwood et al. 2009a) and to serve as a baseline for estimating post-construction impacts such as displacement. Behaviors related to foraging, predator avoidance, social organization and mate acquisition are relatively stable, and are expressed consistently, so one year of surveys should suffice. The surveys need to be performed by behavioral ecologists familiar with the collision issues. Not only should the flight behaviors of birds be recorded, but their flight paths should be related to a digital elevation model of the project area and vegetation cover so that terrain and vegetation can be used to predict flight paths. It is important to predict the major flight paths of species of concern so that the project can be laid out to minimize collision hazard (Smallwood et al. 2009b).

In my experience, behavior surveys are most efficient when they last one hour. Any longer, and the observers grow disinterested and lose focus. Any less, and the efficiency of the surveys is compromised by the logistical demands of closing down surveys, relocating, and starting new surveys. A key point to behavior surveys is that they are not counts of abundance, but rather are supposed to be high-quality recording of flight behaviors. Therefore, quality tracking of individual birds or groups of birds is more important than tracking all of the birds available at any given time.

In the surveys I do, behavior attributes are recorded on point features for use in geographic information system (GIS), but the point features are recorded every few seconds rather than every minute as typical of the use surveys. The point features of course result in line features representing flight paths. It is the flight paths that we can intersect with interesting features of the landscape, proposed or existing solar arrays, fences, or gen-ties. Those point features closest to the intersections of the line features can inform of the height above ground and specific behaviors being performed by the bird. Our capacity for predictive modeling is therefore much greater.

Each survey session begins with wind and temperature measurements, so that I can later relate behavior rates to weather conditions. I record the station number, date, and start time on a handheld map and on two worksheets in an electronic spreadsheet format. These three variables are key variables that enable merging of the data in all three formats when it is time for analysis. As key variables, it is critical that special care be given to recording them consistently and without error. One sheet is for session attributes, such as observer's initials, temperature, wind direction, average and maximum wind speeds, and percentage cloud cover. These attributes are recorded at the start and end of each session, and the values averaged for session representation in analysis. The other sheet is for bird observations during the session, which the observers record into voice recorders during the survey. The first bird I see is assigned letter A, and the first recorded observation of bird A is assigned 1, and the second observation is 2, and so on (Figure 1). These observations are recorded on a field map as A1 and A2, and they are also recorded in a spreadsheet with the same designations. Along with each record, I also record species, height above ground, behavior, number in group, and specific details about near or actual collisions with project infrastructure. The alphanumeric values assigned to birds also serve as key variables enabling the merging of data from field maps and the observation worksheet. All voice recordings must be transcribed to spreadsheets within 24 hours of survey.

Mapped behavior data should be digitized for use in GIS, preferably with the help of a GIS analyst. A simple form of analysis consists of overlaying flight paths of individual species under a range of conditions, such as wind speeds and wind directions, or time of day. Flight patterns should be evident, and potential impacts inferred from the flight paths. A more rigorous analysis would involve constructing predictive models based on associations between flight locations and mapped slope and vegetation measurements. Candidate modeling approaches could be Discriminant Function Analysis or Fuzzy Logic (Smallwood et al. 2009b).

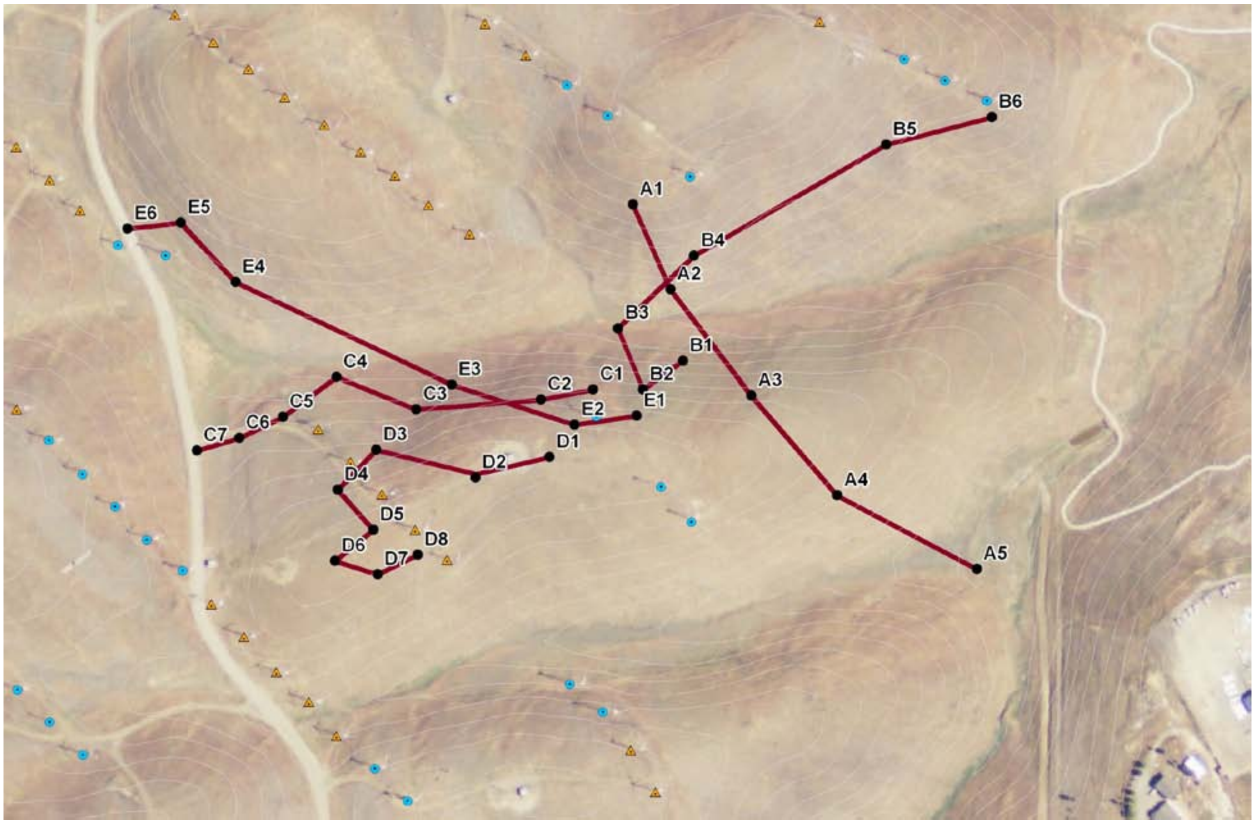

Figure 1. *Example bird flight paths and connecting point features where behavior attributes were recorded. These data were from one of my project sites in the Altamont Pass. The triangles and circles were 40-KW wind turbines*.

To quantify displacement and attraction impacts caused by the project if approved and constructed, the behavior surveys should be continued for a year after construction. A BACI design would help control for variation in behavior rates due to the change in years, although only one impact site will be possible in the design. The BACI design's power would be diminished by the existence of only one real plot representing the impact portion of the design, but it will still yield useful results.

Nocturnal Surveys

I have been using a FLIR T620 thermal imaging camera with an 84 mm lens for about 18 months. I can identify many of the targets to species or at least to larger taxonomic groups, including at distances out to 1,000 m. During hundreds of hours of surveys I have seen many bats flying within my study plots and interacting with the wind turbines in my plots, and I have watched the flights of hundreds of burrowing owls, great-horned owls, and barn owls. I also have observed common poorwills and species usually active during the day, such as cormorants, ducks, and songbirds. I also record mammalian species visiting the wind turbines to forage on birds and bats killed by the wind turbines or placed by my research team for detection trials. I can see where the striped skunks, coyotes, foxes, badgers, raccoons, house cats, and bobcats are going, which can help me tailor the detection trial to more accurately estimate the proportion of fatalities not found during searches (see below).

The FLIR T620 camera and 84 mm lens cost about $31,000 in 2011. Lesser equipment will not be nearly as effective as this camera and lens. The results, however, justify the cost. A tripod is also needed.

I record observations onto handheld map images of the study area. When I record data to the map, I use a red light to minimize my visibility to wildlife. I record attribute data into a voice recorder, which I transcribe to an electronic spreadsheet the next morning. The FLIR T620 also records still photos and video, and I often record my observations in both photo and video formats. The recordings often help me interpret what I saw during the surveys.

The thermal imaging equipment I use enables me to identify most animals to species, but also to observe their behaviors. Observing behaviors is much more useful than obtaining a flight trajectory from radar. I can see how birds and bats react to the renewable energy infrastructure, which is invaluable.

Similar to the diurnal behavior surveys, to quantify displacement and attraction impacts caused by the project, nocturnal surveys should be undertaken before any approval and construction and also continued for a year after construction. A BACI design would help control for variation in nocturnal behavior rates due to the change in years, although only one impact site will be possible in the design. The BACI design's power would be diminished by the existence of only one real plot representing the impact portion of the design, but it will still yield useful results.

Post-construction Fatality Monitoring

Very little is known of the types or magnitudes of impacts on wildlife caused by industrial solar projects. Qualified biologists should be funded to search the ground between arrays of heliostat mirrors on a weekly basis (every two weeks at the longest) for at least three years to determine the magnitude of collision fatalities. Searches should be done on foot. I suggest searching randomly or systematically selected arrays of heliostat mirrors to the extent that equals 33% or more of the project, including all ground between the power towers and the nearest array of heliostat mirrors. Detection trials should be integrated into the searches. At least 10 bird carcasses should be randomly placed within the search areas weekly (10 carcasses project-wide). These carcasses should have been frozen very soon after death, so that the decay process was halted in the incipient stage. If collision fatalities are greater than predicted, then I suggest extending the fatality monitoring for at least another three years.

Furthermore, I would suggest performing an analysis of the pattern of fatalities to identify spatial or other trends that can inform mitigation measures to reduce fatality rates. Basic methods for fatality monitoring at a solar energy plant can be found in McCrary et al. (1986), and updated methodology can be found in Smallwood (2007, 2009, 2013), Smallwood and Karas (2009), Smallwood et al. (2013). A summary is provided below.

The essential elements of scientifically defensible fatality rate estimates include: (1) detecting as many of the available fatalities as possible; and, (2) adjusting the number of found fatalities by the proportion not found. The duration of the average search interval matters greatly to both of these factors. During the past two years I have worked with three search intervals at two studies, including 7 and 28 day intervals at one study and <5 day intervals at another. Also at the latter study, another monitor overlapped many of my study plots with an average search interval of 42 days. What I learned from these various search intervals is that the longer intervals can be more efficient for large bird carcasses, but short search intervals are crucial for obtaining reasonable fatality rate estimates of small birds and bats. I suggest a search interval of no longer than two weeks. A search interval of weekly would be appropriate for bats.

I recommend that at least a third of the project area be searched periodically for dead or injured birds and bats. The project area should be divided into grid cells or other sampling units (such as groups of heliostat mirrors) that are then sampled randomly or systematically (with a random starting point) for inclusion in the fatality monitoring. Standardization of the field and analytical methods should include the following for most species.

1. Periodic fatality searches at time intervals of no more than two weeks. Fatality searches should be conducted along transects separated by no more than 7 m in most environments, but closer if ground visibility is poor and farther apart if ground visibility is excellent. Trained dogs should be used to improve detection rates of bats and very small birds, if necessary. Search intervals should not be split between groups of heliostat mirrors or between seasons.

2. Fatality monitoring should last at least three years, and another three years if significant numbers of fatalities are found during the first year. Surveys should cover all seasons, in order to capture variation due to seasons and multi-annual cycles of abundance or weather conditions.

3. Detection trials should be integrated into routine fatality monitoring, whereby fresh carcasses (very short time between death and when the carcass was placed in a freezer) are marked discreetly and placed at random locations within the fatality search areas and at random times within periodic time intervals such as weekly. Carcasses should be placed at a rate that does not exceed new fatality finds by the searchers. Given the fatality finds of April and May 2014, placing 10 carcasses per week would suffice. The fatality searchers should be blind to the trial to the degree possible. All trial and found carcasses should be left in the field so as not to disrupt the ecology of scavenging in the project area, and so that missed trial carcasses can potentially be found during later searches. Detection rates should be combined, rather than treated separately for searcher detection error and scavenger removal. The proportion of carcasses found should be the metric used to adjust fatality rates, and should not involve mean days to carcass removal.

For its simplicity and freedom from bias when the detection trial is implemented properly, I recommend the Horvitz and Thompson (1952) estimator:

$$F_A = \frac{F_U}{D},$$

Where F_U is the unadjusted number of fatalities/MW/year (the found carcasses), D is the proportion of placed carcasses that is detected by searchers performing standard searches, and F_A

is the fatality rate adjusted for the proportion of carcasses found amongst those that were available to be found fatality throughout a given monitoring period. I calculate the standard error of the adjusted fatality rate, $SE[F_A]$, using the Delta Method (Goodman 1960):

$$\sqrt{\left(\left(\left(\frac{1}{D}\right)\times SE(F_U)\right)^2+\left(\left(F_U\times\left(\frac{-1}{D^2}\right)\right)\times SE(D)\right)^2\right)}$$

where SE stands for standard error, F_A and F_U are adjusted and unadjusted fatality rates, and D is overall detection rate.

The proposed monitoring plan at Ivanpah described in the recent filings would be close to the plan I outlined above (see TN 201315). However, I am concerned that it will encounter some logistical challenges because it relies on many small plots. For Palen, I would recommend that it would be more practical to rely on a smaller number of larger plots so that driving time between plots is minimized. Also, found carcasses should not be used in scavenger removal trials because estimating time since death is highly inaccurate and attempting to do so results in the placement of carcasses that are no longer attractive to vertebrate scavengers. Not using fresh killed or fresh frozen carcasses will result in fatality rate estimates that are biased low.

Biological Resources Mitigation Implementation and Monitoring Plan

The public should have the opportunity to review the BRMIMP. This mitigation planning document is too important to defer its formulation until after the public has read other documents related to this proceeding. What I see in the FSA's summary of mitigation and the filings from the petitioner is frequent referral to the BRMIMP, which is a document on which I will not get to comment other than to say that it should have been circulated to the public prior to any decisions being made on whether the Palen project should be permitted.

Measures to Rectify Impacts

If the project is built, injured birds will sometimes be found alive (also see Kagan et al. 2014). Not all the birds will die immediately after flying into heliostat mirrors or through the zone of solar flux. Given the number of birds being found dead at Ivanpah, I predict that many birds will be found injured and alive at Palen, if Palen is built. The biological monitor will need a plan and a place to send injured birds. In the Altamont Pass Wind Resource Area, the wind companies pay nearby rehabilitation facilities $10,000 per year to handle injured birds as they are brought in from the Altamont Pass. Most of the birds brought to the facilities are euthanized, largely due to budget constraints. I know this first hand because I personally interviewed the rehabilitators to understand why so many of the injured birds were being euthanized, even when some of the injuries seemed relatively minor. If Palen is built, the responsible thing to do would be to provide an annual payment to local rehabilitation facilities. The amount paid would need to cover the number of birds and other wildlife being brought from the project, and it would need to cover sufficient time for the rehabilitators to give the injured animals a chance at recovery rather than a quick needle. The funding should also include an amount that is regarded as a donation for the use of deceased birds that will be needed in detection trials as part of fatality monitoring.

Measures to Reduce Impacts

Avian Protection Plan

Mitigation Measure BIO-16 was named the Avian Protection Plan. Its formulation, however, was deferred to a time subsequent to public participation with this proceeding on Palen. It appears that I will not get the opportunity to review the Avian Protection Plan, which is a shame because I have considerable experience with these types of plans. The summary of the Avian Protection Plan in the FSA provides no details on Plan elements. There was no description of what proportion of the project would be monitored, how it would be monitored, how often searches would be performed, whether detection trials would be implemented, or even anything about the monitoring objectives. In short, the summary of the Avian Monitoring Plan was uninformative and unacceptable.

Curtailment

If the fatality patterns observed at Solar One remain consistent at Palen, then curtailment would apply to only 30% of the fatalities. The other 70% of the fatalities would be caused by collision with heliostat mirrors, and would not be affected by curtailment. Curtailment would potentially reduce fatalities only within that 30% portion of the fatalities that happen within the zone of solar flux. The other 70% of the fatalities would not be affected by curtailment. Even if curtailment applied to 10% of the potential operating time, and assuming that birds die within the zone of solar flux at the same rates during all seasons, this curtailment would reduce the predicted number of 10,787 birds per year to 10,463 birds per year, because the 10% curtailment would apply to the 3,236 birds per year that are killed by solar flux. The net fatality reduction from a 10% curtailment would be 3%, which would probably go undetected in a test for a statistically significant difference.

If pre-construction behavior surveys informed me or another qualified ecologist that a seasonal curtailment could reduce solar flux fatalities by 50%, then the net fatality reduction across the project would be 15%. This fatality reduction might also be found to be statistically insignificant, which in my experience with these types of mitigation measures in the Altamont Pass Wind Resource Area, would fuel strong arguments against continuing the curtailment. Of course, one could assess the fatality reduction only within the zone of solar flux and ignore the collisions with heliostat mirrors. Assessing the mitigation measure this way would probably yield a statistically significant fatality reduction (50%). Either way it is done, however, the decision whether to implement curtailment would mean life or death of 1,618 birds, which is not a trivial number.

The decision over whether to implement curtailment can only be informed through carefully designed and executed pre-construction behavior surveys, or by post-construction fatality surveys. The trouble with relying on post-construction fatality surveys is that by the time the information is acquired, the project has already killed thousands of birds that could have been saved by implementing curtailment based on preconstruction surveys. This decision is also a very good example of why the project needs a qualified TAC that has the power to require monitoring and mitigation plans.

I was one of five members of the Alameda County Scientific Review Committee, which reviewed monitoring and mitigation involving >5,000 wind turbines and thousands of bird fatalities per year. The SRC had access to more monitoring data and more opportunities for mitigation experiments than any other wind resource area in the world, yet mitigation plans failed one after another (Smallwood 2008). After all conceivable measures had been rejected by the wind companies or by Alameda County, or had been implemented with confused results due to confounding factors and weak statistical signals, then Alameda County had the SRC implement adaptive management. Of course, by then (2009) there was no adaptive management to implement because there were no more mitigation measures to try. This is why a qualified TAC needs to be in place well before Palen is built, and the TAC has to have the time and the power to formulate measures that will be implemented according to a schedule that is tied to good monitoring data and which have realistic thresholds upon which to abandon initial measures or to initiate new ones.

I recommended curtailment in the Altamont Pass. In 2005 there was a series of meetings referred to as the Altamont Working Group meetings, and attended by CEC staff (I was working for staff at the time), US Fish and Wildlife Service law enforcement and biologists, California Department of Fish and Game biologists, environmentalists, Alameda and Contra Costa County staff, and the wind companies and their lawyers and consultants. During one of these meetings a consultant to the wind companies approached me during a break and proposed wintertime curtailment of the turbines. He pointed out that only 14% of the annual power was generated over winter, which is when I was estimating that nearly half of the raptors were found dead. I endorsed the idea and the Alameda County Board of Supervisors then wrote it into the new Conditional Operating Permits, which the SRC then reviewed and recommended modifications as information became available since that time. The SRC could only make recommendations; it lacked the authority to require measures or changes to monitoring. As a consequence, the curtailment never conformed to the SRC's recommended four month shutdown, and the fatality monitoring was performed with a search interval that was too long to detect an effect of the shutdown. During the five years I was a member of the SRC, the SRC argued internally and with the wind companies over whether the curtailment was effective. Winter curtailment continued through the winter of 2013-2014, and still there has been no confirmation that the curtailment strategy worked. Again, strategies such as curtailment need good information at the start, as well as a qualified group of scientists who can assess the information and require changes as needed.

Avian Deterrent Strategies

Document TN 201838, entitled "*Palen Solar Holdings, LLC's Review of Potential Bird Deterrent Strategies for Large Scale Solar Facilities*," summarizes avian deterrent strategies. Any efforts to deter birds protected by the Migratory Bird Treaty Act could be interpreted as "take" or "pursuit," and may not be legal. Deterrents can even cause fatalities by scaring birds into the very facilities the measures were intended to keep birds away. Avian deterrents also have a poor record of success because birds readily habituate to deterrents.

Balloons were identified as a possible deterrent (Document TN 201838). It was even suggested that eyes could be painted on the balloons. A study was cited where balloons were tried, but it was not surprising to read that the results varied by species and were generally negative. In my experience, balloons would have little if any effectiveness at deterring birds.

Scarecrows were suggested next. However, we have a long history with scarecrows, which have not worked.

The document then introduced the Eagle Eye, a device that spins ever-changing light beams on nearby structures, but TN 201838 made no mention of measured results in any study. I would suspect that no mention of efficacy means that there has been no measure of efficacy. If it worked, trust me, it would have been deployed in the Altamont Pass Wind Resource Area. I warn that if it was deployed amongst heliostat mirrors, we would likely seen more fatalities rather than fewer because birds startled by light beams flashing off the heliostat mirrors would then fly into the mirrors.

Lasers were next. Just like the Eagle Eye, deploying lasers in an array of heliostat mirrors is likely to cause panic flights and confusion. I cannot recommend such a reckless measure.

Lights followed lasers. Again, flashing lights in a field of heliostat mirrors would be imprudent.

TN 201838 then suggested UV-reflective paint, which was acknowledged to have failed in its application at a wind project. Another problem with this approach would be the loss of reflected light after painting the mirrors with UV-reflective paint. This deterrent seems ludicrous.

The document then lists auditory deterrents, none of which have a proven record of success. These measures, such as gas canons, startle birds, which then settle back into the area they're not supposed to be using. Startling birds amongst heliostat mirrors is probably not a good idea.

The document lists pursuit strategies, such as using dogs, falcons and drones. However, it would be a violation of the Migratory Bird Treaty Act to pursue birds protected by this Act. It would also cause some birds to fly into heliostat mirrors, perhaps more often than if they were not pursued.

The document briefly summarizes expensive systems that detect incoming birds and then haze them. I have seen no scientific evidence that these systems are effective, and no good evidence was offered in TN 201838. And again, using such systems might very well scare birds into heliostat mirrors.

The document suggested that some yet-to-be-discovered method might be used to disorient the magnetic fields of birds. Another approach with just as much sense would be to cut off one or both wings of birds so that they cannot fly at all.

It was misleading to suggest that any of these bird deterrent strategies could contribute to an effective adaptive management program.

Compensatory Mitigation

I failed to find any compensatory mitigation measure to offset impacts caused by bird collisions with heliostat mirrors or by thermal injuries. Given what was found at Solar One and at Ivanpah, there is ample reason to conclude that fatalities will happen. There will be fatalities caused by Palen if permitted and constructed. A compensatory mitigation plan should be formulated to address these impacts, and the amounts of compensation should be linked to fatality levels and to monitoring to measure fatality levels.

Fencing

Cyclone fencing can entangle and kill wildlife (Photo 1). Care should be taken when planning and installing fencing. More details about fence construction should be provided in the environmental review documentation.

***Photo 1**. A great-horned owl died after becoming entangled on the razor wire placed on top of this cyclone fence. Photo by Joanne Mount.*

DECLARATION OF K. SHAWN SMALLWOOD, Ph.D.

I, Shawn Smallwood, declare as follows:

1. I am a self-employed ecologist based in Davis, California.

2. My professional qualifications are given in the attached Curriculum Vitae.

3. I prepared the attached corrected testimony relating to Biological Resources for the Committee Order Granting Petitioner's Motion to Reopen the Evidentiary Record and Setting Revised Schedule (California Energy Commission Docket Number 09-AFC-7C).

6. It is my professional opinion that the attached prepared testimony is valid and accurate with respect to issues that it addresses.

7. I am personally familiar with the facts and conclusions related in the attached prepared testimony and if called as a witness could testify competently thereto.

I declare under penalty of perjury, under the laws of the State of California, that the foregoing is true and correct to the best of my knowledge and that this declaration was executed on 14 July, 2014.

________________________ 14 July 2014

Shawn Smallwood, Ph.D.

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