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STATE OF CALIFORNIA

Energy Resources
Conservation and Development Commission

In the Matter of: Petition For Amendment for the **PALEN SOLAR ELECTRIC GENERATING SYSTEM**	**DOCKET NO. 09-AFC-07C** **DECLARATION OF WALLY ERICKSON**

I, Wally Erickson, declare as follows:

1. I am presently employed by West Inc.

2. A copy of my professional qualifications and experience was included with my Rebuttal Testimony and is incorporated by reference in this Declaration.

3. I prepared the attached testimony relating to Biological Resources for the Petition for Amendment for the Palen Solar Electric Generating System (California Energy Commission Docket Number 09-AFC-07C).

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

5. 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 June 20 2014.

Wally Erickson

Wally Erickson

STATE OF CALIFORNIA

Energy Resources
Conservation and Development Commission

In the Matter of: Petition For Amendment for the **PALEN SOLAR ELECTRIC GENERATING SYSTEM**	**DOCKET NO. 09-AFC-07C** **DECLARATION OF KEN LEVENSTEIN**

I, Ken Levenstein, declare as follows:

1. I am presently employed as a Project Manager by West Inc.

2. A copy of my professional qualifications and experience is included with my Supplemental Testimony.

3. I prepared the attached testimony relating to Biological Resources for the Petition for Amendment for the Palen Solar Electric Generating System (California Energy Commission Docket Number 09-AFC-07C).

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

5. 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 20 JUNE 2014.

[signature]

Ken Levenstein

PALEN SOLAR ELECTRIC GENERATING SYSTEM
BIOLOGICAL RESOURCES
SUPPLEMENAL OPENING TESTIMONY
AVIAN IMPACTS

I. Names:

Wally P. Erickson
Dr. Ken Levenstein

II. Purpose:

Our supplemental testimony addresses the potential impacts, mitigation and adaptive management techniques for Biological Resources – Avian, associated with the construction and operation of the Palen Solar Electric Generating System (PSEGS) (09-AFC-7C).

III. Qualifications:

Wally P. Erickson:

I am the Chief Operating Officer/Senior Biometrician at Western EcoSystems Technology, Inc (WEST) and have been employed in that capacity since 1991. I have a MS in Statistics and have over 23 years of consulting experience related to the design and analysis of environmental and wildlife studies. I have been the lead statistician/project manager for WEST for baseline studies, environmental permitting, and/or operational monitoring/research at wind energy projects in over 30 states. I have participated in numerous assessment and monitoring projects related to understanding and assessing the effects of wind turbines on birds and bats, and in avian and bat risk reduction studies. I have been involved in studies involving use of radar, and other remote sensing methods, for detecting birds and bats at wind facilities, and with methods used to reduce or minimize impacts such as prey reduction, acoustic and visual deterrents and other methods. I have also developed Avian and Bat Protection Plans (ABPP), Bird and Bat Conservation Strategies (BBCS) and Eagle Conservation Plans (ECP) for several wind projects. I prepared Exhibit 1139 which provides a description of currently available avian deterrent methods that will be considered for incorporation into the BBCS. I also prepared Exhibit 1156 which provides an estimate of the avian mortality expected from a 500 MW wind energy project. I am also currently preparing the BBCS for the Palen Solar Electric Generating System (PSEGS). A detailed description of my qualifications has been previously provided in Attachment A to Palen Solar Holding's (PSH) Opening Testimony package.

Dr. Ken Levenstein:

I am a Project Manager and Avian Ecologist at Western EcoSystems Technology, Inc (WEST) and have been employed in that capacity since 2011. I have a Ph.D. in Environmental Science with a focus in Avian Ecology and have been involved in avian research for 20 years. In previous positions I have worked in the area of avian research throughout the U.S., in Central America, and conducted my doctoral dissertation research on the reproductive ecology of Galápagos hawks (*Buteo galapagoensis*) in the Galápagos Islands, 600 miles west of Ecuador. As a postdoctoral research associate with the University of Washington, Seattle, I worked in the Northern Mariana Islands (a U.S. Commonwealth in the Western Pacific) as Director of Field Research on the federally endangered Mariana crow and Rota bridled white-eye. Since entering the world of environmental consulting, I have been able to apply my expertise in avian behavior and ecology to the field of renewable energy facility/wildlife interaction research. As a Project Manager for WEST, I have managed baseline studies, environmental permitting, and/or operational monitoring/research at a number of wind energy projects in southern California and have been involved in baseline studies at several solar facilities. The work I have conducted and managed at the locations of proposed solar facilities has included golden eagle nest surveys (by air and by ground), golden eagle spatial use surveys, bird use count surveys (BUCs), small bird count surveys (SBCs), raptor migration surveys, and nocturnal songbird migration studies using radar. I have also developed Avian and Bat Protection Plans (ABPP), Bird and Bat Conservation Strategies (BBCS) and Eagle Conservation Plans (ECP) for several wind projects. I have co-managed the baseline avian studies for PSEGS since summer 2013 and am currently managing and one of the authors on the BBCS for the Project. A detailed description of my qualifications is attached...

III. <u>Opinion and Conclusions</u>:

Avian Comparison Table

The Committee provided direction at the PMPD Conference that it would like the PSEGS evidentiary record to provide a comparison of avian impacts with other technologies. To provide a rough comparison we have compiled Exhibit 1133 which provides publicly available avian mortality data reported by First Solar for its Desert Sunlight Project (DSP) photovoltaic (PV) facility, NextEra for its Genesis Solar Energy Project (GSEP) solar trough facility; and the Ivanpah Solar Electric Generating System (ISEGS) solar power tower facility. As the Committee acknowledged at the PMPD Conference, the data reported by the facilities are imperfect but are the only publicly available data. While there are differences in data collection methods and the quantity and quality of the data, they provide some information on the similarities or possible differences in the species and taxa composition among the different technologies. Based on a comparison of the mortality data collected to date, imperfect as it is, it appears that the potential impacts from highly concentrated solar flux, as it occurs in an area immediately surrounding the solar collector tower, may warrant specific mitigation and adaptive management techniques since this sort of highly concentrated solar flux zone is not generated at either solar trough or PV facilities. However, as was suggested in a USFWS Office of Law Enforcement (OLE) preliminary study of mortalities at DSP, GSEP, and ISEGS, it also appears that heliostat fields may pose a reduced risk to birds relative to PV or solar trough facilities due to less dense spacing and multi-axis mobility. Compared to PV panels and parabolic troughs, heliostats also offer the greatest potential to employ adaptive management techniques involving different stowing positions to reduce avian collision impacts at PSEGS.

Some Parties have argued that the Committee should require years of data from ISEGS in order to be able to evaluate the potential impacts associated with highly concentrated solar flux for the PSEGS. However, the data on avian mortality from the various technologies and particularly the data from ongoing monitoring efforts at ISEGS, which began collecting data over a year ago, do not support such a contention.

First, the ISEGS project is one of very few solar projects that have conducted systematic searches and reported findings to date. It is our understanding that the area around each tower, within 850 feet, has been searched systematically since spring 2013 at ISEGS, and 20% of the heliostat fields surrounding each tower have been searched since October 2013. These systematic searches provide a better data set to understand what is happening at the ISEGS project. Although systematic monitoring at other projects is anticipated in the future, currently, the other datasets are largely composed of incidental reporting. For DSP and GSEP, the avian mortality monitoring consists of reporting dead birds that are found incidentally by construction workers or biological monitors while conducting other activities. The number of carcasses reported in incidental monitoring is likely a function of the amount of activity and effort in the facility during construction and operations. That common sense relationship does appear to be apparent based on the index of activity compared to carcass finds from DSP and GSEP and the USFWS OLE is aware of this (Exhibit 1154).

Second, the projects are at various stages of construction and operation and are also of different sizes and at different locations and encompass different avian settings and habitat types. The GSEP is a 250 MW solar trough facility encompassing approximately 1,800 acres. The DSP is a 550 MW PV facility encompassing approximately 3,761 acres, and ISEGS is a 377 MW solar power tower facility encompassing approximately 3,200 acres. In order to provide a more accurate estimate of the potential avian mortality that could occur from the No Project Alternative (500 MW solar trough), mortality data would need to be extrapolated based on metrics like the acreages of solar fields, number of buildings, length of transmission or distribution lines, etc. (See Exhibit 1155).

Third, and most importantly, the avian mortality studies conducted to date do not include any effort to evaluate deterrent methods or adaptive management techniques. As the Committee knows, PSH has committed to a comprehensive adaptive management program embodied in Conditions of Certification **BIO-16b,** which will require the development, testing and implementation of deterrent methods tailored to the avian species that are being impacted by the PSEGS. In addition, the PSEGS is the only project that has committed to the funding of substantial mitigation activities (Condition of Certification **BIO-16a**) up front that the Technical Advisory Committee (TAC) can direct to programs to benefit the actual species or group of species being impacted by the PSEGS.

To place the potential impacts in a broader context, based on our experience, we would expect the monitoring of wind turbines at a wind project with the capacity to generate 500 MW in an area with an avian setting similar to the PSEGS to result in avian mortality of approximately 1,700 carcasses per year on average. Based on studies in the region, we would expect most fatalities at a wind project would be songbirds, with some raptors, waterfowl, waterbirds, and other avian groups represented as well.

Based on our risk assessment and a comparison of species composition data amongst current studies, which is included in the Draft BBCS (Exhibit 1139), the mortality from an average wind energy project is not unlike what is estimated for this solar facility. Furthermore, this solar facility and an average wind energy project would be expected to generally affect similar assemblages of bird taxa. An example of an expected difference in assemblages is that we anticipate potentially more turkey vulture mortality at PSEGS compared to the other projects.

It is very important to put these numbers into some context. In fact, the most significant concern over impacts to many wildlife populations, including birds, is over the effects of climate change (Foden et al. 2013) and habitat loss (BirdLife International website). Climate change has already affected birds and their habitats in a number of ways, causing: 1) changes in behavior and phenology, such as timing of migration and nesting; 2) range shifts (displacement) and contractions; 3) disruption of species interactions and communities; and 4) exacerbation of other threats and stresses, such as disease, invasive species and habitat fragmentation, destruction and degradation (BirdLife International 2008). Over the past 40 years, climate change has produced shifts in the abundances and distributions of species and has been implicated in at least one species-level extinction (Thomas et al. 2004). PSEGS directly contributes to combating climate change as part of the State’s shift to renewable energy.

After the effects of climate change and habitat loss, studies to date have indicated the highest mortality of birds due to anthropogenic causes comes from predation by domestic and feral cats (Loss et al. 2013) followed closely behind by collisions with windows (e.g., from houses, office towers, commercial structures; Klem 2009). Other sources that are not easily quantified in terms of total number of annual fatalities, but are well documented mortality sources, include power lines, vehicles (Loss et al. 2014), communication towers (Longcore et al. 2012), oil field wastewater disposal facilities, wind turbines (Zimmerling et al. 2013), aircraft, lead poisoning from hunting ammunition (Kerlinger 2013), power plant discharge ponds, fences, fishing nets, oil spills, and parking lots (see Exhibit 1157).

Songbirds appear to be the most common group impacted by colliding with tall towers (particularly the guy wires often associated with these structures), buildings and vehicles, while ducks and other waterfowl appear to make up a small percentage of birds that collide with these sources. The primary anthropogenic source of waterfowl mortality is legal hunting, which resulted in the harvest of nearly 19 million ducks and geese in the U.S. alone in 2012. Other sources of mortality for waterbirds and waterfowl include road vehicle collisions, powerline electrocutions and collisions, communication tower collisions, cat predation, agricultural pesticides, and marine gillnets (Calvert et al. 2013). Nest destruction is associated with haying and mowing, commercial forestry, powerline maintenance, hydroelectric reservoirs, terrestrial oil and gas activities, mining, and road maintenance (Calvert et al. 2013). Studies like Longcore et al. (2013) and Erickson et al. (2014, in review) suggest that avian mortality cumulatively from thousands of communication towers and wind turbines for the great majority of waterfowl, songbirds, and waterbirds, is a relatively minor source of mortality for individual species populations.

In addition, the data in Exhibit 1157 can be used to identify mitigation opportunities by the TAC when directing the PSEGS mitigation funding.

Some of the risk factors associated with bird mortality at structures include siting of the facilities, use of guy wires, lighting, and height of structures. Based on the extensive pre-construction survey data for PSEGS, the project does not appear to be in a high bird use area. While turkey vulture use is relatively high, the site has low raptor use (excluding vultures) when compared to other projects in the region. In addition, guy wires at communication and meteorological towers appear to be a very significant risk factor for birds. No guy wires are associated with the PSEGS solar power towers. Solid red lights on infrastructure also appear to be an attractant to birds at night, especially during poor weather conditions, and this has led to large nighttime fatality events at some structures, especially those with guy wires. While the PSEGS towers are relatively tall, the risk of collision at night should be relatively low, given there are no guy wires. It is important that the minimum amount of lighting to meet FAA standards is used on the towers. The PSEGS towers are solid which is different than the lattice structure employed at ISEGS, so internal safety lighting (on stairways, walkways, and platforms, for example) will not be viewable from the outside, thereby reducing lighting attraction. In addition, according to the meteorological data and our experience on the site, the area doesn't experience frequent foggy conditions, thereby decreasing the potential for a large avian fatality event.

One avoidance measure that has been considered for wind energy projects is curtailment of individual turbines or groups of turbines when birds are approaching. This measure has been employed, for example, at the Ocotillo wind project using observations of incoming birds by biological monitors with the aid of radar and other technology. This curtailment approach has been considered feasible in some cases at wind energy facilities because the turbines can be controlled individually, and the turbine rotors or blades can be slowed to decrease risk to birds in less than a minute or so. The technology at a concentrated solar facility cannot be changed in such short order, so a similar curtailment application like the one at Ocotillo and other wind energy projects is not possible for this facility. As described in the Exhibit 1137, Biological Resources Supplemental Opening Testimony of Gustavo Buhacoff, it would take up to 30 minutes to discontinue production of highly concentrated solar flux by moving the heliostats from focusing on the receiver to the stow position. While the heliostats can be moved to a standby position in a shorter time period, the risk to birds could potentially be increased because moving heliostats to a standby position can potentially increase the area of highly concentrated flux away from the tower. Therefore, quick curtailment to respond to incoming birds would not be as effective for PSEGS as for a wind turbine project. The more effective approach would be to use deterrent methods in such an event (see further discussion below). In addition, the data collected at ISEGS have not shown that any large fatality events (e.g., greater than 25 birds on a search day) have occurred at the facility. Since solar flux is not generated at night, concern over significant or large impacts to migrating songbirds is greatly reduced.

Bird and Bat Conservation Strategy (BBCS)

PSEGS is currently in the process of preparing a BBCS for the PSEGS and has completed a first draft of the document (see Exhibit 1139). The BBCS includes the methods and results of all avian and bat related baseline studies conducted to date at the Project site and provides a risk assessment for various avian species-groups (e.g., waterfowl, diurnal raptors, passerines, etc.) based on the results of the baseline studies. A large number of studies have been and continue to be conducted at the site, far exceeding efforts at other solar projects. See Exhibit 1158 for a summary of these efforts. In fact, the preconstruction surveys provide more comprehensive baseline information on avian use for any solar energy project considered by the California Energy Commission. The wealth of baseline data at the PSEGS provides an excellent starting point to further study the changes in avian use at the site during construction and operation of a power tower facility. Studies at a facility such as PSEGS, which can rely on a robust set of baseline data, will lead to a better understanding of the relationship between large scale solar projects and avian use during and after construction. This data can be used to inform future siting decisions and it can assist PSEGS and future projects to design monitoring, detection, and deterrent methods.

Risk Assessment

The data collected as a result of the PSEGS pre-construction surveys can be used to evaluate avian species use and composition, determine how avian use at this site compares to other sites, and estimate potential exposure to solar flux. For example, overall, use of the Project study area (including a 1-mile buffer), by diurnal raptors has been low relative to the locations of other proposed Southwestern U.S. renewable energy (wind) projects where pre-construction studies have been conducted (see Exhibit 1159)

We conducted a quantitative risk assessment based on the pre-construction information and models of highly concentrated solar flux surrounding the solar collector tower to better understand and estimate the potential level of magnitude of impacts to a number of taxonomic groups from the zone of risk. We conservatively predicted numbers of bird passages, by major taxonomic groups, through the area where levels of highly concentrated solar flux equals or exceeds levels that may cause effects. The predicted numbers of flights accounted for various assumptions about bird avoidance of concentrated solar flux and operational conditions at the towers over the course of one year.

We were provided a simulation of flux around a tower at PSEGS (Exhibit 1160) which, according to the assumptions provided to us, include conservative operational conditions (i.e., larger and/or more intense flux conditions than are likely to be present during much of the operational time). Using this simulation, we assigned risk to a region in space, centered near the top of the tower, including the majority of regions ranging from 25 kW/m^2 to and including all regions of 50 kW/m^2 or greater flux. This risk region takes the form of a cylinder 100 m in radius extending from 176 to 280 m above ground level. As shown on Exhibits 1161 and 1162, which plot the ISEGS avian data, this level of highly concentrated flux is consistent with the mortality data collected at ISEGS where, as indicated by the distribution of flux damaged carcasses, the vast majority of flux damage appears to be taking place near the tower.

Systematic bird use surveys were conducted at the PSEGS site during fall 2013. Surveys targeted larger birds, such as diurnal raptors, waterfowl, and vultures, as well as small song birds. Flight path data were recorded, as well as estimated flight height upon detection. Using these data, we estimated the number of flight paths potentially passing through the region of risk.

In lieu of any comparable model for 'collision' with the concentrated flux zone (or, non-avoidance) we adopted a frame work similar to that of the USFWS fatality prediction model for eagles (USFWS 2013). After estimating bird exposure, we modeled non-avoidance probability (the complement of avoidance) using four scenarios with progressively lower mean (decreasing probability of flight through risk zones) and lower variance. This method assumes that birds will actively avoid regions of highly concentrated solar flux based on both visual cues (higher light intensity and/or presence of the tower) and/or through deterrent technologies.

Results

It is estimated that approximately 665 to 1228 flight paths of birds would be exposed to solar flux within the danger zone per year under a no avoidance or no attraction assumption. Of the taxonomic groups investigated, and using the more conservative assumptions, passerines have the potential for the highest level of exposure (229 – 764) while turkey vultures are the second most common group identified (332). Other large bird taxonomic groups that are expected to have some potential exposure include diurnal raptors (30), with buteos (16) having the most potential for exposure, followed by falcons (7).

In addition, we modeled exposure rates under the assumption that there would be some level of avoidance by birds of the area around the tower. Birds are known to avoid potential collision with buildings and other tall structures, especially during the day when the flux is occurring. In addition, it is anticipated that deterrents will be used to increase avoidance around the tower. With assumptions of 50%, 75%, 90%, 95% and 99% avoidance, the number of estimated fatalities is reduced in a proportional progression.

Monitoring Plan

The BBCS also includes a comprehensive monitoring plan to quantify the levels of impact from the project, and focus additional monitoring, research and mitigation through an adaptive management process which will include testing and updating of the risk assessment. The monitoring plan will be designed to estimate Project impacts to birds and bats, and will incorporate measures to adjust the data for uncertainty.

Experimental bias trials that are standard in avian fatality monitoring studies will be conducted to correct for missed birds due to searcher efficiency bias and scavenger bias. It has also been hypothesized that birds passing through highly concentrated solar flux may be vaporized (i.e., completely incinerated). Based on the information collected to date at ISEGS, it does not appear that vaporization of birds is possible. We have seen very little difference in the condition of birds that show signs of concentrated flux damage at ISEGS. If some birds were being vaporized, it would be expected that at least some bird carcasses would also show feather charring or more severe damage from highly concentrated flux than is being observed among the carcasses found at ISEGS. It is likely that a bird's impaired ability to continue to fly after being exposed to flux would keep it from traveling through the flux zone to a point of vaporization. The condition of birds with injuries from exposure to highly concentrated flux and/or any further evidence encountered will be monitored during operations to provide additional information useful for investigating the vaporization theory, but at this point it appears highly unlikely such a hypothesis has any merit.

In addition to the currently unsupported vaporization hypothesis, it has also been hypothesized that some birds may be slightly injured from exposure to highly concentrated flux and then fly offsite before they die. The same concern is associated with wind energy facilities where birds injured from collision may fly or walk away outside the search area depending on their condition and go undetected by searches.

There are some differences between the morbidity issue at a wind energy facility and this solar facility. First, monitoring at a wind energy facility focuses on the area around turbines, typically within a maximum distance from the turbines equivalent to the height of a turbine to the tip of one of its blades in vertical position. Searches are not generally conducted more than approximately 100 meters away from a turbine string (group of turbines in a row). However, since searches will be conducted in a large area around the solar power tower, as well as within the heliostats, we will be able to gather evidence to evaluate the morbidity issue at the project. For example, searches will be conducted within heliostats up to approximately 2,700 meters from the nearest tower and approximately 5,400 meters from the tower that is not the nearest tower, which will provide some information on morbidity of birds injured from exposure to highly concentrated solar flux at great distances from the towers. In addition, some sampling will be conducted offsite, which will provide further information on whether birds impacted by the project are subsequently moving offsite before they die.

Data from ISEGS do not appear to support the hypothesis that monitoring will significantly underestimate mortality due to birds being impacted by the project and landing outside the search areas. Exhibit 1162 shows a superimposed picture of concentrated solar flux modeled for Palen and the flux injury fatalities at ISEGS based on the information provided in the monthly reports through April 2014. Very few of the carcasses landed outside the estimated area of concentrated solar flux and most of those that did were close to the edge of the area. There have been few birds with flux related injuries found outside this area, and the density of birds with flux related injuries clearly shows a rapidly declining rate with increasing distance from the tower (Exhibit 1162), with the evidence of decline initiating well within an 850 feet radial perimeter. It is our understanding the area within 850 feet of the tower has been searched since

March 2013. This evidence suggests that few birds with flux related injuries would be expected to end up outside the area of searches.

Adaptive Management

Monitoring information collected at the PSEGS will feed into an adaptive management process for making management and operational decisions. An extensive series of mitigation measures and advanced conservation practices (ACPs) will be incorporated into the construction and operation phases of the Project to reduce any risk that might be posed by the facility to birds and bats.

Inherent to the adaptive management process at the PSEGS will be a plan to experimentally test a series of methods aimed at reducing risk that might be posed by the Project to birds and bats. These methods will include:

- Detection and deterrent methods to determine the most effective technologies for implementation at the Project.
- An experimental test of heliostat positioning regimes
- Potentially modifying the lighting scheme at the Project
- Direct compensatory mitigation funds proportional to species/taxa groups impacted

To mitigate potential risks posed by the PSEGS to birds and bats, PSH is committed to testing methods, identified through review of the above studies and included in the Adaptive Management chapter of the PSEGS BBCS, aimed at mitigating for and potentially having a net benefit to bird and bat populations in the area, even given potential mortalities at the Project.

Deterrent Methods

Exhibit 1130 provides a description of current and developing avian deterrent methods and techniques. Avian deterrent technology is developing rapidly and Exhibit 1130 was included to provide the Committee with some examples of the types of methods and techniques available to the PSEGS and the Technical Advisory Committee (TAC) organized pursuant to Condition of Certification **BIO-16b.** As Exhibit 1130 identifies, the effectiveness of deterrent methods can be highly dependent upon species and whether a species becomes acclimated to the deterrent technique. Therefore, the approach that is anticipated by the Conditions of Certification allows the TAC to recommend deterrent methods, monitor those methods, and make modifications to deterrent methods or employ new methods as data from the comprehensive monitoring of the PSEGS during operation are collected.

We have observed videos of birds being deterred by sound in relation to a transmission tower and have been collaborating with BirdsVision Ltd. on other applications of their technology. An advantage of using this technology at solar energy facilities as opposed to wind energy facilities is that wind facilities represent a cluttered environment with moving turbine tips and blades that make it very difficult to detect birds. However, the technology has been successful in deterring birds from stationary structures akin to those found at solar energy facilities.

Performance Standards

The Committee directed the parties to consider using performance standards as a way to mitigate uncertainty and implement adaptive management. We agree that performance standards or adaptive management thresholds are a useful tool that has been used in other similar contexts for implementing management actions at wind projects. However, it is important to note that the traditional use of performance standards is to ensure that impacts do not rise above the threshold of significance set for evaluation under the California Environmental Quality Act (CEQA). In the case of the PSEGS, PSH is not requesting the Committee to find that the PSEGS does not result in significant impacts to avian species. PSH is willing to proceed with a finding that avian impacts at the PSEGS are significant and, due solely to uncertainty, may not be fully mitigated. With that in mind, we believe that the best approach to incorporate performance standards would be to propose performance standards that can be modified and implemented by the TAC as appropriate. Performance standards may be developed to help answer the questions below:

1. What are the most effective technologies or combination of technologies for detection and deterrent methods to avoid and reduce mortality of birds and bats?
2. What positioning of heliostats at night results in the least impact to birds as determined by an experimental test of heliostat positioning regimes?
3. What is the best use of compensatory mitigation funds and how may they best be proportionally applied to species/taxa groups impacted?
4. What additional monitoring, mitigation or research should be conducted if mortality is higher than predicted?
5. If mortality on a given day or a given period is considered high based on a specific threshold, what were the factors that appeared to be related to the event or series of events?

Mitigation

PSEGS has voluntarily committed compensatory mitigation funds to help offset bird mortality that occurs due to operations at the Project. These funds will be directed to programs that benefit birds of taxa similar to those impacted by the project. For example, if songbirds incur fatalities, contributions will be made to programs that benefit songbirds. Some examples of the types of activities that will lead to compensatory benefits for various bird groups are identified below.

- **Songbirds**: Marking fences, feral cat control (e.g., neutering/spaying), window markings

- **Water birds/waterfowl**: Salton Sea habitat improvement efforts, overhead line marking

- **Raptors**: Power pole retrofits, marking fences, overhead lines

The compensatory benefits from these activities depend on many factors. However, general resource equivalency models have been developed that do demonstrate the benefits of these methods. PSH has indicated that they intend to dedicate $300,000 to retro-fitting power poles as part of a mitigation package to aid in migratory bird conservation. The 2013 U.S. Fish and Wildlife Service (USFWS) Eagle Conservation Plan Guidance: Module 1 – Land-based Wind Energy document recommends power-pole retro-fits as compensatory mitigation to offset eagle take and provide a resource equivalency analysis (REA) to quantify the number of power-pole retro-fits needed to offset the loss of an eagle (USFWS 2013). The USFWS REA calculates the value of an eagle as well as the reproductive value of the lost eagle over two generations. Therefore, by using the USFWS power-pole retrofit REA, we can quantify the number of eagles (and the reproductive value of those eagles over two generations) that are expected to be mitigated for by retro-fitting a specified number of power-poles. Assuming that eagles and other raptors have similar demographic characteristics, we can also provide an estimate of the benefits of power-pole retrofits to other raptors given the electrocution rates of other raptors relative to eagles based on publicly available data from the literature.

The cost to retrofit (re-frame) power poles has been generally estimated to range from $800 to $4000 per pole. For our analysis, we assume that it will cost $2,000 to retro-fit a power-pole, and under that assumption Palen is proposing to provide funding to retro-fit 150 power-poles. One of the variables that influences the number of power-pole retrofits needed to offset eagle take under the USFWS power-pole retrofit REA is whether or not the retrofit(s) are installed upfront (prior to take of an eagle) and how far in advance of the expected take the retrofits are installed. If the retrofits are installed prior to operation of a 30 year project (i.e., the retrofitting is for some level of anticipated take over the next 30 years), the number of retrofitted poles per eagle is approximately 9.2 (USFWS 2013). Alternatively, if poles are retrofitted while take occurs, the number of retrofitted poles per eagle is approximately 14.12. Both scenarios assume that the retrofits are maintained for 30 years (retrofits result in 30 years of avoided eagle loss). Since there is no predicted level of expected eagle or raptor take for the PSEGS, we assume that 14.12 power-pole retrofits will offset the take of one eagle based on the USFWS power-pole retro-fit REA. Therefore, we estimate that by retrofitting 150 power-poles, Palen will mitigate for the loss of approximately 10 eagles and the reproductive value of those ten eagles over two generations.

In addition to eagles, power-pole retrofits have the potential to benefit a number of other raptor species. Over 30 raptor species have been reported as electrocution mortalities in the U.S. (Hunting 2002). Lehman et al. (2010) assessed patterns of raptor mortality due to electrocutions in northwestern Colorado and northeastern Utah. Estimated mortality rates for hawks and owls were similar to eagles, suggesting that hawks and owls were as likely to be electrocuted as eagles in spite of inherent size differences (Lehman et al. 2010). The authors hypothesized that the large numbers of poles in high-risk categories may have contributed to unusually high mortality rates for hawks and owls. Based on these findings, as well as the assumption that eagles and other raptors have similar demographic characteristics, we estimate that Palen will mitigate for the loss of an additional 10 other raptors (and the reproductive value of those ten raptors over two generations) by retrofitting 150 high-risk power-poles.

Retro-fitting high-risk power-poles will provide a benefit to both eagles and other raptors. Based on the above assessment, by retro-fitting 150 high-risk power poles, Palen could mitigate for the loss of 20 raptors (10 eagles and 10 other raptors) and the reproductive value of those 20 raptors over two generations.

WEST has investigated other measures that could be funded from the $1.2 million PSEGS contribution to bird conservation to voluntarily mitigate impacts to birds as a result of solar flux.

As identified by many bird conservation groups, feral cats represent a significant threat to bird and other wildlife populations. See Exhibit 1163, letter from American Bird Conservancy, National Audubon Society, and others to the US Secretary or Interior, and Exhibit 1164, letter from the American Bird Conservancy to the US Secretary of Interior. After reviewing the letters, WEST developed a resource equivalency analysis that equates bird mortality to a feral cat removal or neutering (spaying) program (see Attachment A). PSEGS is not proposing to conduct its own feral cat program, but believes the TAC could direct funding to existing or new programs that can have a significant positive effect on passerines and songbirds to adequately mitigate the mortality impacts the PSEGS could have on those groups of birds. The current version of Condition of Certification **BIO-16a**, developed by the Commission Staff and agreed to by PSH, provides the flexibility of the TAC to direct funding to animal control programs.

Determining the number of songbirds taken per cat per year is difficult because predation is difficult to observe. Estimates of cat predation rates on songbirds range from 4 to more than 100 per year (Exhibit 1165), again, with most published estimates assumed to be conservative (i.e., low). We used a value near the middle of the range of reported rates to calculate the number of songbirds expected to be taken by a female cat, her daughters, and her matrilineal granddaughters (see Attachment A). Each generation is calculated independently of the others, so the number of songbird mortalities resulting from one cat plus one generation of her female offspring is 112 + 874 = 986 songbird mortalities per female cat. Alternatively, if a neutering program is used, and songbird credits are calculated over two generations of offspring, 874 songbirds may be saved per female cat spayed.

By including two generations of offspring in the analysis, a spaying program alone could result in 874+20,618 songbirds saved per female cat. Attachment A and the values presented here are in terms of female cats produced per female. If a cat control or spaying and neutering program is implemented for both sexes, as is likely to be the case, total credits would be half of what is calculated here. This is conservative inasmuch as male cat-years in generations two and three are not counted towards the bird credit. Clearly, as suggested by the bird conservation groups in the previously-mentioned letters, contributions to programs designed to reduce bird mortality from feral cats could greatly benefit birds, especially songbirds.

Other approaches that could be considered include marking other overhead lines or fences or guy wires from tall structures with markers that make the wires more visible to wildlife. Several studies have been conducted that have shown significant reductions including up to 90% reduction in bird mortality by use of marking in some cases. In addition, another very effective tool is to remove fences or overhead lines that are no longer being used. Songbirds, game birds, raptors, waterfowl and waterbirds are impacted by collision with wires. The number of birds that might be saved by such measures will depend on the location of the fences or overhead lines, but can be a very useful and effective mitigation tool.

References

AECOM. 2009. Palen Solar Power Project Biological Technical Report. Riverside County, California. Submitted to Solar Millennium, LLC, Berkeley, California, and Chevron Energy.

Anderson, R. L., D. Strickland, J. Tom, N. Neumann, W. Erickson, J. Cleckler, G. Mayorga, G. Nuhn, A. Leuders, J. Schneider, L. Backus, P. Becker, and N. Flagg. 2000. Avian Monitoring and Risk Assessment at Tehachapi Pass and San Gorgonio Pass Wind Resource Areas, California: Phase 1 Preliminary Results. *In*: Proceedings of the National AvianWind Power Planning Meeting III (PNAWPPM-III), May 1998, San Diego, California. National Wind Coordinating Collaborative (NWCC)/RESOLVE, Washington, D.C. Pp 31-46.

BirdLife International. 2008. Threatened Birds of the World. CD-ROM. BirdLife International, Cambridge, UK. http://www.birdlife.org/

BirdLife International website. Pressure: Why Birds Are Declining. Case Studies (State of the Worl'd Birds), BirdLife International. Accessed April 2014. Information available online at: http://www.birdlife.org/datazone/sowb/pressure?gclid=CIHUlcSOgLsCFe%20UDOgodemQA3A

Bloom Biological, Inc. (BBI). 2013a. Palen Solar Electric Generating Facility Spring 2013 Avian Survey Results. Prepared for Palen Solar Holdings, Inc., Oakland, California. Prepared by BBI, Lake Forest, California. July 2013.

Bloom Biological, Inc. (BBI). 2013b. Palen Solar Electric Generating Facility Summer 2013 Avian Survey Results. Prepared for Palen Solar Holdings, Inc., Oakland, California. Prepared by BBI, Lake Forest, California. August 2013.

Bloom Biological, Inc. (BBI). 2013c. Palen Solar Electric Generating System 2013 Golden Eagle Nesting Survey Results. Prepared for Palen Solar Holdings, Inc., Oakland, California. Prepared by BBI, Lake Forest, California. October 2013.

Bloom Biological, Inc. (BBI). 2013d. Palen Solar Electric Generating System Winter 2013 Golden Eagle Survey Results. Prepared for Palen Solar Holdings, Inc., Oakland, California. Prepared by BBI, Lake Forest, California. March 2013.

Bloom Biological, Inc. (BBI). 2013e. Palen Solar Electric Generating Facility Spring 2013 Avian Survey Results Supplement. Prepared for Palen Solar Holdings, Inc., Oakland, California. Prepared by BBI, Lake Forest, California. July 2013.

Brown, P. E., and W. E. Rainey. 2013. Bat Habitat Assessment for Palen Solar Electric Generation System. Conducted for Alice E. Karl and Associates. Conducted by Brown-Berry Biological Consulting. July 20, 2013.

Brown, P. E., and W. E. Rainey. 2014. Bat Habitat Assessment for Palen Solar Electric Generation System. Conducted for Alice E. Karl and Associates. Conducted by Brown-Berry Biological Consulting. May 17, 2014.

Calvert, A. M., C. A. Bishop, R. D. Elliot, E. A. Krebs, T. M. Kydd, C. S. Machtans, and G. J. Robertson. 2013. A Synthesis of Human-Related Avian Mortality in Canada. Avian Conservation and Ecology 8(2): 11; http://dx.doi.org/10.5751/ACE-00581-080211

Chatfield, A., W. P. Erickson, and K. Bay. 2011. Avian Baseline Studies for the Alta East Wind Resource Area, Kern County, California. Draft Final Report: July 10, 2010 - June 1, 2011. Prepared for CH2M HILL, Oakland, California. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

Coleman, J. S. and S. A. Temple. 1996. On the Prowl. Wisconsin Natural Resources: December issue.

Crooks, K. R. and M. E. Soulé. 1999. Meso-Predator Release and Avifaunal Extinctions in a Fragmented System. Nature 400: 563-566.

Dauphine, N. and R. J. Cooper. 2009. Impacts of Free-Ranging Domestic Cats (*Felis catus*) on Birds in the United States: A Review of Recent Research with Conservation and Management Recommendations. Proceedings of the Fourth International Partners in Flight Conference: Tundra to Tropics: 205-219.

Dolbeer, R. A., S. E. Wright, M. J. Begier, and J. Weller. 2009. Wildlife Strikes to Civil Aircraft in the United States 1990-2008. Federal Aviation Administration National Wildlife Strike Database Serial Report Number 15. Report of the Associate Administrator of Airports Office of Airport Safety and Standards & Certification, Washington, DC.

EDAW AECOM. 2009. Palen Solar Power Project Burrowing Owl Technical Report. July 2009.

EDAW AECOM and Bloom Biological, Inc. (BBI). 2009. Palen Solar Power Project Avian Point Count Survey Technical Report. Prepared for Solar Millennium, LLC and Chevron Energy Solutions. August 2009.

Erickson, W. P., A. Chatfield, and K. Bay. 2011. Avian Baseline Studies for the North Sky River Wind Energy Project, Kern County, California. Final Report: May 18, 2010 – May 26, 2011. Final Report. Prepared for CH2M HILL, Portland Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. July 7, 2011.

Erickson, W. P., D. Johnson, J. L. Gehring, M. Wolfe, and K. Bay. 2014 (in review). A Comprehensive Review and Analysis of Data on Small Passerine Fatality Impacts Due to Wind Energy Facilities with Comparisons to Impacts from Communications Towers and Other Sources. PLoS ONE.

Erickson, W. P., G. D. Johnson, and D. P. Young, Jr. 2005. Summary and Causes of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. USDA Forest Service Technical Report PSW-GTR-191.

Erickson, W. P., G. D. Johnson, D. P. Young, D. Strickland, R. Good, M. Bourassa, K. Bay, and K. Sernka. 2002. Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments. Technical report prepared for Bonneville Power Administration, Portland, Oregon by WEST, Inc., Cheyenne, Wyoming. December 2002. http://www.bpa.gov/Power/pgc/wind/Avian_and_Bat_Study_12-2002.pdf

Fiore, C. and K. B. Sullivan. 2000. Domestic Cat (*Felis catus*) Predation of Birds in an Urban Environment. M.S. Thesis. Wichita State University, Wichita, Kansas.

Foden, W. B., S. H. M. Butchart, S. N. Stuart, J.-C. Vié, H. R. Akçakaya, A. Angulo, L. M. DeVantier, A. Gutsche, E. Turak, L. Cao, S. D. Donner, V. Katariya, R. Bernard, R. A. Holland, A. F. Hughes, S. E. O'Hanlon, S. T. Garnett, Ç. H. Şekercioğlu, and G. M. Mace. 2013. Identifying the World's Most Climate Change Vulnerable Species: A Systematic Trait-Based Assessment of All Birds, Amphibians and Corals. PLoS ONE 8(6): e65427. doi:65410.61371/journal.pone.0065427.

Hildreth, A. M., S. M. Vanatassel, and S. E. Hygenstrom. 2010. Feral Cats and Their Management. EC1781. University of Nebraska Extension Service. 7pp.

Hunting, K. 2002. A Roadmap for Pier Research on Avian Collisions with Power Lines in California. Public Interest Energy Research Program (PIER), Commission Staff Report, P500-02-071F. December 2002. Available online at: http://www.energy.ca.gov/reports/2002-12-24_500-02-071F.PDF

Karl, A. E. 2013. Palen Solar Electric Generating System Supplemental Spring 2013 Biological Surveys. Prepared for Palen Solar Holdings, LLC. July, 2014

Kerlinger, P. 2013. Hypocrisy over Bald Eagle Protection from Wind Turbines Begins at the Federal Level. North American Windpower. Available online at: http://www.nawindpower.com/e107_plugins/content/content.php?content.11846

Kerlinger, P., L. Culp, and R. Curry. 2005. Post-Construction Avian Monitoring Study for the High Winds Wind Power Project, Solano County, California. Year One Report. Prepared for High Winds, LLC and FPL Energy.

Klem, D. Jr. 2009. Avian Mortality at Windows: The Second Largest Human Source of Bird Mortality on Earth. Pp. 244-251. *In*: Proceedings of the 4th International Partners in Flight Conference: Tundra to Tropics. T. D. Rich, C. Arizmendi, D. Demarest, and C. Thompson, eds. McAllen, Texas.

Lehman, R. N., J. A. Savidge, P. L. Kennedy, and R. E. Harness. 2010. Raptor Electrocution Rates for a Utility in the Intermountain Western United States. Journal of Wildlife Management 74(3): 459-470.

Lepczyk, C. A., A. G. Mertig, and J. Liu. 2004. Landowners and Cat Predation across Rural-to-Urban Landscapes. Biological Conservation (115): 191-201.

Levenstein, K., A. Chatfield, W. Erickson, and K. Bay. 2014. Fall 2013 Avian Field Surveys for the Palen Solar Electric Generating System, Riverside County, California. Prepared for Palen Solar Holdings, LLC. February 13, 2014.

Levenstein, K. and C. Nations. 2014. Fall 2013 Nocturnal Migration Surveys for the Palen Solar Electric Generating System, Riverside County, California. Final Report. Prepared for Palen Solar Holdings, LLC. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

Longcore, T., C. Rich, P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S.A. Gauthreaux, Jr., M. L. Avery, R. L. Crawford, A.M. Manville, II, E. R. Travis, and D. Drake. 2012. An Estimate of Avian Mortality at Communication Towers in the United States and Canada. PLoS ONE 7(4): e34025. doi: 34010.31371/journal.pone.0034025.

Longcore, T., C. Rich, P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S.A. Gauthreaux, Jr., M. L. Avery, R. L. Crawford, A.M. Manville, II, E. R. Travis, and D. Drake. 2013. Avian Mortality at Communication Towers in the United States and Canada: Which Species, How Many, and Where? USDA National Wildlife Research Center - Staff Publications. Paper 1162. http://digitalcommons.unl.edu/icwdm_usdanwrc/1162

Loss, S. R., W. T, and P. P. Mara. 2014. Estimation of Bird-Vehicle Collision Mortality on U.S. Roads. Journal of Wildlife Management: doi: 10.1002/jwmg.721.

Loss, S. R., T. Will, and P. P. Marra. 2013. The Impact of Free-Ranging Domestic Cats on Wildlife of the United States. Natural Communications 4: 1396.

Mitchell, J. C. and R. A. Beck. 1992. Free-Ranging Domestic Cat Predation on Native Vertebrates in Rural and Urban Virgina. Virginia Journal of Science 43: 197-206.

Orloff, S. and A. Flannery. 1992. Wind Turbine Effects on Avian Activity, Habitat Use, and Mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final Report P700-92-001 to Alameda, Contra Costa, and Solano Counties, and the California Energy Commission, Sacramento, California, by Biosystems Analysis, Inc., Tiburon, California. March 1992.

Peck, D. R., L. Faulquier, P. Pinet, S. Jaquemet, and M. Le Corre. 2008. Feral Cat Diet and Impact on Sooty Terns at Juan de Nova Island, Mozambique Channel. Animal Conservation 11: 65-74.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and Economic Costs of Non-Indigenous Species in the United States. Bioscience 50: 53-65.

Thomas, C. D., A. Cameron, R. E. Green, M. Bakkenes, L. J. Beaumont, Y. C. Collingham, B. F. N. Erasmus, M.F. de Siqueira, A. Grainger, L. Hannah, L. Hughes, B. Huntley, A.S. van Jaarsveld, G. F. Midgley, L. Miles, M. A. Ortega-Huerta, A. T. Peterson, O. L. Phillips, and S. E. Williams. 2004. Extinction Risk from Climate Change. Nature 427: 145-148.

US Fish and Wildlife Service (USFWS). 2009. Migratory Bird Mortality in Oilfield Wastewater Disposal Facilities Wyoming Ecological Services Field Office - Environmental Contaminants Program. Available online at: http://www.fws.gov/mountain-prairie/contaminants/documents/COWDFBirdMortality.pdf

US Fish and Wildlife Service (USFWS). 2013. Eagle Conservation Plan Guidance. Module 1 - Land-Based Wind Energy. Version 2. Division of Migratory Bird Management, USFWS. April 2013. Available online at: http://www.fws.gov/migratorybirds/Eagle_Conservation_Plan_Guidance-Module%201.pdf

Western EcoSystems Technology, Inc. (WEST). 2006. Diablo Winds Wildlife Monitoring Progress Report, March 2005 - February 2006. Technical report submitted to FPL Energy and Alameda County California. WEST. Cheyenne, Wyoming.

Western EcoSystems Technology, Inc. (WEST), the Colorado Plateau Research Station (CPRS), and the Ecological Monitoring and Assessment Program. 2006. Avian Studies for the Proposed Sunshine Wind Park, Coconino County, Arizona. Prepared for Sunshine Arizona Wind Energy, LLC., Flagstaff, Arizona, by WEST, Cheyenne, Wyoming, and the CPRS and the Ecological Monitoring and Assessment Program, Northern Arizona University, Flagstaff, Arizona. May 2006.

Young, D.P. Jr., G. D. Johnson, V. K. Poulton, and K. Bay. 2007a. Ecological Baseline Studies for the Hatchet Ridge Wind Energy Project, Shasta County, California. Prepared for Hatchet Ridge Wind, LLC, Portland, Oregon by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. August 31, 2007. Available online from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentVersionID=41939

Young, D.P. Jr., V. K. Poulton, and K. Bay. 2007b. Ecological Baseline Studies Report. Proposed Dry Lake Wind Project, Navajo County, Arizona. Prepared for PPM Energy, Portland, Oregon, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. July 1, 2007.

Zimmerling, J. R., A. C. Pomeroy, M. V. d'Entremont, and C. M. Francis. 2013. Canadian Estimate of Bird Mortality Due to Collisions and Direct Habitat Loss Associated with Wind Turbine Developments. Avian Conservation and Ecology 8(2): 10. http://dx.doi.org/10.5751/ACE-00609-080210.

Attachment A

A primer on Resource Equivalency Analysis and its application to a cat-control
program as compensatory mitigation for incidental take of songbirds

Paul Rabie and Wally Erickson – WEST Inc.

Resource equivalency analysis (REA) is a modeling strategy that allows 'apples to apples' comparisons among apparently dissimilar resources. In this document we construct a prototypical equivalency model that relates cats to songbirds through the process of predation.

We begin with the observation that cats kill songbirds and recognize a negative relationship between numbers of cats and numbers of songbirds. But songbird predation is a *process* and as such it unfolds through time. The number of songbirds accruing to a cat depends on the amount of time that the cat has to hunt. Researchers typically calculate songbird predation as songbirds per cat *per year*. It follows that the appropriate equivalency is songbirds per cat-year.

songbirds = cat - years * birds per cat per year

Because cat-years are important to the equivalency, it is necessary to calculate the number of cat-years per cat. It immediately becomes apparent that removal of a kitten from the population is more effective in terms predation reduction than removal of an elderly cat, because the average kitten will live much longer than the average elderly cat.

Further, removal of a cat from the population reduces the amount of time available to that particular cat, but also (if the cat is a female) the amount of time available to its kittens[1]. Cats are prolific reproducers, and accounting for cat-years due to future generations would quickly produce numbers that are unwieldy. To avoid this problem we consider only two future generations of cats[2]: the single cat in question (generation 0, or *Gen0* for short), plus the kittens it would have had (*Gen1*), plus its kittens' kittens (*Gen2*).

In calculating total cat years, we assume that Gen0 is drawn at random from the population, and the number of years it might live is then the average life expectancy over the whole population. Similarly, the number of kittens in Gen1 is the average number of kittens expected from a random female cat in the population (note that this number includes kittens from multiple litters). But the number of cat-years per cat in Gen1 and Gen2 are both equal to the life expectancy of a kitten, and the number of cats in Gen2 is the number of kittens expected over the life of a kitten. For the REA we have developed below, this calculation is:

Component	**Total cat years =**
Gen0	Average life expectancy +
Gen1	Average number of kittens from a cat * life expectancy of a kitten +
Gen2	Average number of kittens from a cat * average number of kittens from a kitten * life

[1] As is the case for most population modeling exercises, males are considered nearly irrelevant to population dynamics, and are ignored. The strategy is to base all calculations on females and then assume that half of the cat population is female.

[2] There is precedent for this in the USFWS REA for golden eagles, and use of this precedent here is conservative because two generations of golden eagles live much longer than two generations of cats.

	expectancy of a kitten

In practice, the REA would be calculated on the basis of half of the cats removed from the population because males contribute very little to population dynamics.

There is one further complication to the calculation of total cat years. In general, a bird tomorrow is not valued the same as a bird today; there is a discount applied to future birds. In the current context, we can discount future cat years and achieve the same effect. A typical discount for future natural resources is 3% per year[3]. The complete calculations to achieve a 3% per year discount for future cat years are cumbersome but to illustrate the idea, the life expectancy for a kitten in the REA below is 2.13 years. To apply a 3% per year discount means that the number of cat-years credited to a kitten born this year is

$1 * 0.97^0 + 1 * 0.97^1 + 0.13 * 0.97^2 = 2.09$

and the number of cat-years credited to a kitten born next year is

$1 * 0.97^1 + 1 * 0.97^2 + 0.13 * 0.97^3 = 2.03$.

Determining the number of songbirds taken per cat per year is difficult because predation is difficult to observe. Almost all published estimates of cat predation rates indicate that they are conservative (i.e. probably low). Here we used a value near the middle of the range of reported rates to calculate the number of songbirds expected to be taken by a cat, her daughters, and her matrilineal granddaughters. Each generation is calculated independently of the others, so the number of songbirds owing to one cat plus one generation of her female offspring is 112 + 874 = 986 songbirds per female cat. Alternatively, if a neutering program is used, and songbird credits are calculated over two generations of offspring the credit per female cat neutered is 874 + 20,618 = 21,492 present-value songbirds per female cat. The table and the values presented here are in terms of female cats per female. If a cat control or neuter program is implemented for both sexes (as is likely to be the case), total credits would be half what is calculated here. This is conservative inasmuch as male cat-years in generations two and three are not counted towards the bird credit.

[3] Again, by analogy to the USFWS golden eagle REA

Calculation basis	Female cat-years calculated without discount	Present value female cat years (after 3% per year discount)	Present-value songbirds, assuming 52 birds per cat per year
One female cat	2.28	2.15	112
Female offspring from one female cat	19.6	16.8	874
Second-generation matrilineal female offspring from one female cat	576.5	396.5	20,618
Total	598.3	415.4	21,600

Kenneth M. Levenstein, Ph.D., *Project Manager*

PROFESSIONAL EXPERIENCE

2011-Present	*Project Manager*, Western EcoSystems Technology, Inc., Arcata, California
2009-2011	*Senior Ornithologist,* BHE Environmental, Inc., Cincinnati, Ohio
2008-2009	*Postdoctoral Research Associate*, University of Washington, Department of Psychology (Animal Behavior), Seattle, Washington
2001-2008	*Ph.D. Research,* Arkansas State University, Jonesboro, Arkansas and Galápagos, Ecuador
2007, 2008	*Independent Contract Biologist,* Arkansas Game and Fish Commission, Little Rock, Arkansas
2006-2007	*Field Supervisor,* The Cornell Lab of Ornithology, Ithaca, New York
2006	*Biologist,* The USGS Patuxent Wildlife Research Center, Vicksburg, Mississippi
2006	*Biologist,* USGS Arkansas Cooperative Fish and Wildlife Research Unit, Fayetteville, Arkansas
2005-2006	*Crew Leader/Biologist,* The Cornell Lab of Ornithology, Ithaca, New York

SPECIALTY AREAS

Dr. Ken Levenstein has close to 20 years of experience studying avian ecology across the United States and overseas, both in academia and the private sector. Raised in the Los Angeles area, Ken joined the staff of WEST as an Avian Ecologist and Project Manager in 2011 and is currently managing projects for renewable energy clients in Southern California.

Renewable Energy and Energy-Transmission Corridor Studies: Ken is experienced in managing all phases of pre-and post-construction studies at renewable energy projects, mitigation compliance monitoring at facilities under construction, and MBTA compliance surveys and monitoring both on the ground (Oklahoma, Kansas, Wyoming, Montana, and South Dakota) and by air (golden eagle/raptor nest surveys by helicopter; Wyoming, Montana, and South Dakota) for corridor construction projects. Ken has experience with all aspects of project management including budget preparation, hiring and training field survey crews, coordinating with clients, designing wildlife studies to meet the needs of clients and resource agencies, study implementation, and report preparation. Studies have included initial site evaluation, pre-construction avian and bat use surveys, nocturnal migration radar studies, threatened, endangered, and sensitive species surveys, golden eagle behavioral observation/spatial use studies, ground- and aerial-based raptor nest surveys, breeding bird surveys, land cover/habitat mapping, post-construction avian and bat fatality monitoring, and golden eagle radar mitigation studies.

Wildlife Studies: Ken has extensive knowledge of avian research methodologies; fixed-point-, line-transect-, territory mapping-surveys, nest searching, golden eagle/raptor nest surveys (helicopter-based), radio telemetry, aerial telemetry (fixed-wing-based), constant effort and targeted mist-netting (1000s processed), and capture-mark-recapture studies and analyses.

Threatened and Endangered Species: T&E species research, surveys, and monitoring; species include research on a number of rare, threatened, and endangered species include: *southwestern willow flycatcher*, California, Arizona, and Nevada, along the entire Lower Colorado River from the Grand Canyon to the Mexican border - searched for and monitored territories and nests, banded adults and nestlings, resighted color-banded individuals; *Bicknell's thrush*, Vermont - searched for and monitored territories and nests, banded adults and nestlings, resighted color-banded individuals; *California Gnatcatcher*, California - searched for and monitored territories, resighted color-banded individuals; *Mariana crow*, Rota, Northern Mariana Islands - searched for and monitored territories and nests, banded adults and nestlings, resighted color-banded individuals, radio-telemetry, conducted nest observations (video); *Rota bridled white-eye*, Rota, Northern Mariana Islands - searched for and monitored territories and nests, conducted nest observations (video); *Galápagos hawk*, Isla Santiago, Galápagos - banded adults and nestlings, resighted color-banded individuals, searched for and monitored territories and nests, conducted nest observations from blind*; marbled murrelet*, Olympic Peninsula, Washington – surveyed old growth forest and timberlands for breeding adults.

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The Wildlife Society

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Raptor Research Foundation

Wilson Ornithological Society

SELECTED PROFESSIONAL PUBLICATIONS AND REPORTS

Levenstein, K., A. Chatfield, W. Erickson, K. Bay. 2014. Fall 2013 Avian Field Surveys for the Palen Solar Electric Generating System, Riverside County, California. Final Report. Prepared for Palen Solar Holdings, LLC.

Levenstein, K., and C. Nations. 2014. Fall 2013 Nocturnal Migration Surveys for the Palen Solar Electric Generating System Riverside County, California. Final Report. Prepared for Palen Solar Holdings, LLC.

Erickson, W., A. Chatfield, **K. Levenstein**, and K. Taylor. 2014. Draft Eagle Management Plan North Sky River Wind Energy Project, Kern County, California. Prepared for NextEra Energy.

Levenstein, K., A. Chatfield, E. Baumgartner, and K. Bay. 2014. Post-Construction Studies for the North Sky River Wind Energy Facility, Kern County, California. Final Report for the First Year of Operation, January 2013 – January 2014. Prepared for North Sky River Energy, LLC.

Rivera-Parra, J.L., **K. M. Levenstein**, J.C. Bednarz, F.H. Vargas, V. Carrion, and P.G. Parker. Implications of goat eradication on the survivorship of the Galápagos Hawk. 2012. The Journal of Wildlife Management 76(6):1197–1204.

Levenstein, K., Z. Courage, D. Solick, and M. Sonnenberg. 2012. Nocturnal Migration Studies for the Proposed Rio Mesa Solar Energy Facility Riverside County, California. Final Report Spring and Fall 2012. Prepared for URS Corporation.

Levenstein, K. M., T.J. Benson, J.C. Bednarz, and P.G. Parker. Does differential female/male survival among immature Galápagos Hawks contribute to the maintenance of cooperative polyandry in this species? In Prep

Levenstein, K. M., Bednarz, J. C., Cannon, M. D., and Parker, P. G. Group dynamics and reproductive success of the cooperatively polyandrous Galápagos Hawk: are males and females locked in a gender conflict over the benefits and costs of reproduction. In Prep

Levenstein, K. M., and Bednarz, J. C. Territorial prey resources a determinant of group size in the cooperatively polyandrous Galápagos Hawk. In Prep

BHE Environmental, Inc., 2010-2011. Numerous Fatal Flaw and Phase I Bird And Bat Impact Assessments, Confidential Clients, Proposed Wind Farms, Midwest U.S.

Rorbaugh, R., Lammartink, M., Rosenberg, K., Piorkowski, M., Barker, S., and **Levenstein, K.**, Final Report (Grant Agreement # 401816G060) 2006-07 Ivory-billed Woodpecker Surveys and Equipment Loan Program, Submitted to, U.S. Fish and Wildlife Service, U.S. Geological Survey, National Fish and Wildlife Foundation, National Ivory-billed Woodpecker Recovery Team.

Levenstein, K. M., and Bednarz, J. C. 2004. Final Report: Breeding ecology and prey distribution of the Galápagos Hawk on Santiago Island, Galápagos, Ecuador. Submitted to The Charles Darwin Foundation and Research Station, and the Galápagos National Park.

Bednarz, J. C., Parker, P. G., Donaghy Cannon, M., Bollmer J. L., **Levenstein, K.**, 2002. Final Report (Grant Number: 6821-00) Population studies on the Galápagos Hawk: ecology and genetics. Submitted to The National Geographic Society.

SELECTED PROFESSIONAL PRESENTATIONS

Levenstein, K. M., Berry, L., and Ha, R. 2009. Update on the status of Mariana Crow (*Corvus kubaryi*) and Rota Bridled White-eye (*Zosterops rotensis*) Ecological Research, Rota, CNMI. Annual Brown Treesnake Working Group Technical Meeting, Saipan, Commonwealth of the Northern Mariana Islands.

Levenstein, K. M., Bednarz, J. C., Cannon, M. D., and Parker, P. G. 2005. Reproductive ecology of the cooperatively polyandrous Galápagos Hawk: how many males are enough – and who decides? 123rd stated meeting of the American Ornithologists Union, Santa Barbara, CA

Levenstein, K. M., Bednarz, J. C., Cannon, M. D., and Parker, P. G. 2005. Survivorship analysis on a population of marked Galápagos Hawks (*Buteo galapagoensis*): are cooperating males benefiting from a longer life? Raptor Research Foundation Annual Meeting, Green Bay, WI

Levenstein, K. M. and Bednarz, J. C. 2004. Apparent prey specialization by male Galápagos Hawks (*Buteo galapagoensis*) engaged in rearing young. Raptor Research Foundation Annual Meeting, Bakersfield,, CA

Levenstein, K. M., Bednarz, J. C., Cannon, M. D., and Parker, P. G. 2003. Relationship between group size and reproductive success in the cooperatively polyandrous Galápagos Hawk (*Buteo galapagoensis*). Raptor Research Foundation Annual Meeting, Anchorage, Alaska.

Levenstein, K. M., Cannon, M. D., Cannon, B. J., Bednarz, J. C., Bollmer, J. L., and Parker P. G. 2003. Galápagos Hawk group plasticity. Charles Darwin Research Station, Santa Cruz Island, Galápagos, Ecuador.

Levenstein, K. M., Cannon, M. D., Cannon, B. J., Bednarz, J. C., Bollmer, J. L., and Parker P. G. 2002. Group membership dynamism in the cooperatively polyandrous Galápagos Hawk. The 3rd North American Ornithological Conference, New Orleans, Louisiana

Levenstein, K. M., and Bednarz, J. C. 2001. Skew in copulation frequency between new and established males in polyandrous groups of Galápagos Hawks (*Buteo galapagoensis*). The Raptor Research Foundation's Annual Meeting, Winnipeg, Canada

SELECTED GRANTS AND AWARDS

NAOC Travel Award, Wilson Ornithological Society. (Declined) 2006
American Ornithologists Union, Marcia Brady Tucker Travel Award. 2005
American Ornithologists Union, Wetmore Research Grant. 2004
National Academy of Sciences, Sigma Xi Grant in Aid of Research. 2004
Arkansas Audubon Society Trust. 2004
Arkansas State University Graduate Research Fund. 2004
Arkansas Audubon Society Trust. 2003
Arkansas Audubon Society Trust. 2002

TEACHING EXPERIENCE

GRADUATE TEACHING ASSISTANT: Arkansas State University

2004 – Lecture – Zoology (ZOOL 1043)
2004 – Lab – Ornithology (ZOOL 4263/5263)
2003 – 2004 – Lab – Biological Science (BIOL 1001)
2001 – 2002 – Lecture – Biological Science (BIOL 1001)

GUEST LECTURER: Arkansas State University

2007 – Advanced Analytical Methods for Ecological Data (ESCI 7121)
2004 – Ornithology (ZOOL 4263/5263)
2003 – Conservation Biology (ENVR 4003/5003)
2001 – Animal Ecology (ZOOL 4203/5203)