DOCKETED

Docket Number:	16-EPIC-01
Project Title:	EPIC Idea Exchange
TN #:	215753
Document Title:	Dustin Mulvaney Comments: Avian-solar interactions / lake effect
Description:	N/A
Filer:	System
Organization:	Dustin Mulvaney
Submitter Role:	Public
Submission Date:	2/3/2017 8:56:04 AM
Docketed Date:	2/3/2017

Comment Received From: Dustin Mulvaney
Submitted On: 2/3/2017
Docket Number: 16-EPIC-01

Avian-solar interactions / lake effect

Additional submitted attachment is included below.

December 16, 2016

Dear Aleecia Gutierrez, Angela Hockaday, and other CEC EPIC staff,

We are writing with great interest in the "lake effect" research question in the recent California Energy Commission Electric Program Investment Charge Program Group 1 project area 1 in solicitation GFO-16-309.[1] The CEC specifically requested: *"A project funded under this group would determine whether there is evidence to support the lake effect hypothesis, or an alternative, and suggest methods to mitigate this impact."* The goal of this letter is to provide specific recommendations for how this important research question could be answered using advanced methodological approaches from avian behavioral/sensory ecology and geospatial science. Our team from San Jose State University and Purdue University did not submit a proposal this round, but plan to apply to future opportunities should the CEC continue to support this area of inquiry.

Our experience and familiarity with research on avian-solar interactions and the development of novel strategies to minimize bird-aircraft collisions suggests that the CEC question about the lake effect requires a cause-effect (or mechanistic) rather than a correlational approach. Monitoring efforts have documented patterns of avian mortality in solar photovoltaic (PV) and concentrating solar power (CSP) facilities. The findings suggest that birds are somehow drawn to these facilities, yet the fundamental unanswered question is *why*. This question cannot be fully answered by simply associating avian use/mortality at different solar facilities with their polarized-light reflectance patterns, because such correlational studies (1) cannot establish cause-effect relationships (Ruxton & Colegrave 2010), and (2) can miss identifying key factors that indirectly (but strongly) influence the variables being measured (Shipley 2002). Consequently, the results of such correlational approaches may be weak and may lead to misleading conclusions (Ruxton & Colegrave 2010), which can make mitigation efforts even more challenging. We advocate for a more mechanistic approach (Blumstein & Fernandez-Juricic 2010), which is receiving strong support in conservation biology and the wildlife sciences these days (e.g., Horodysky et al. 2015).

To really address *why* birds are being drawn to solar facilities with a cause-effect approach, we recommend three stages. First, identify the mechanism/s implicated in the already documented patterns of avian use/mortality. The mechanisms put forward to explain these patterns share a common threat: they assume that the avian visual system is challenged by the visual signal coming off the solar panels. Although birds are visually oriented organisms, their visual perception is very different from human visual perception. Birds can see more colors, process images at a faster rate, better distinguish between hues, etc. Therefore, to identify the mechanism, it is imperative to understand how birds really perceive visually solar panels and

[1] http://www.energy.ca.gov/contracts/epic.html#GFO-16-306

respond to their visual signals (Tanaka 2015). This requires four steps: **(1)** measure properties of the visual system (e.g., visual field configuration, position of the centers of acute vision, sensitivity of the retina to chromatic and achromatic signals, etc.) of the species with higher risk of collision (e.g., loons, grebes, etc.); **(2)** use perceptual models (i.e., mathematical algorithms developed to establish how species with different visual configurations perceive an object in relation to the visual background (Vorobyev and Osorio 1998) to determine how visually conspicuous or inconspicuous solar panels are for birds; **(3)** reverse-engineer these perceptual models to establish which visual signal manipulations would reduce or enhance the perception of the solar panel signal; **(4)** conduct aviary experiments to corroborate at the individual level the predictions generated by the perceptual models. This last step is key to ensuring that the model predictions about perception are associated with the expected behavioral responses.

We envision that a mechanistic approach to the CEC request ought to include multiple alternative hypotheses: **(a)** lake-effect (i.e., visual signal of solar facilities is similar to the visual signal from large bodies of water), **(b)** high polarized light pollution (i.e., solar facilities enhance the polarized light signal ultimately attracting birds), **(c)** glare effects (i.e., solar facilities generate levels of light intensity that overwhelm the avian visual system, generating a sensory confusion effect that leads the animals to land immediately before resuming the flight), **(d)** high chromatic and/or achromatic contrast (i.e., solar facilities generate high levels of chromatic and/or achromatic signals relative to the surrounding landscape, which birds are attracted to because they are in their visual sweet-spot), **(e)** low or neutral chromatic and/or achromatic contrast (i.e., solar facilities generate levels of chromatic and/or achromatic signals that are lower than or similar to the surrounding landscape, so the observed patterns of mortality would be simply a random sample of birds landing in any landscape element), and **(f)** visual illusion (i.e., solar facilities generate a visual signal whose components – chromatic, achromatic, polarized- are not generally seen by birds, leading to animal being attracted to the solar facilities to explore this source). Testing the predictions of these alternative hypotheses would ensure higher chances of identifying the specific mechanism/s underlying avian responses to solar facilities. Testing *only* the predictions of the lake-effect may prevent researchers from establishing cues other than those coming from polarized light (e.g., chromatic, achromatic, etc.) that may have a stronger influence on bird responses given the way the avian visual system is configured (i.e., greater perceptual relevance is placed on chromatic/achromatic cues than on polarized cues).

Second, an understanding of the mechanism identified in the first phase will allow any research team to make very specific predictions about the behavior of animals (e.g., attraction, avoidance, neutral) based on the visual signal of the heliostats or photovoltaic modules. These predictions can be tested in the field by manipulating the visual signal (increasing it, decreasing it, keeping it the same, removing it) reflected by models of heliostats and photovoltaic modules and measuring avian behavior and mortality. The responses of birds in this second phase should corroborate the findings identified in the first phase to make a stronger argument about the underlying mechanism/s.

Third, geospatial data can be collected in the field to inform patterns of attraction/mortality in different solar facilities and reference areas and associate them to factors measured in the field (ambient light conditions, availability of different landscape elements, etc.) that are consistent with the mechanism/s identified in the first two stages.

Previous studies on avian collisions with heliostats and photovoltaic modules have often used the correlational approach explained in the third phase. However, we are concerned that not addressing the first and second phases will prevent the development of successful management efforts directed to mitigate these collisions. Combining the three phases described before would provide a strong foundation for recommendations on how to minimize avian attraction to solar power facilities and ultimately mortality. This understanding will be necessary to provide a scientific basis for suggesting possible mitigation approaches, such as modifications to the visual signals coming from the solar arrays, making the development of avian deterrents more successful. This integrative approach will save the industry money, time, and negative publicity relative to avian mortality.

Thank you for your consideration,

Dustin Mulvaney
Associate Professor
Environmental Studies Department
San Jose State University

Esteban Fernandez-Juricic
Professor & Showalter Faculty Scholar
Department of Biological Sciences
Purdue University

Papers cited

Blumstein, D.T. & E. Fernandez-Juricic. 2010. A Primer of Conservation Behavior. Sinauer Associates, Sunderland.

Ruxton, G.D. & N. Colegrave. 2010. Experimental design for the life sciences. Oxford University Press.

Shipley, B. 2002. Cause and Correlation in Biology: A User's Guide to Path Analysis, Structural Equations and Causal Inference. Cambridge University Press.

Horodysky, A.Z, S.J. Cooke & R.W. Brill. 2015. Physiology in the service of fisheries science: Why thinking mechanistically matters. Rev Fish Biol Fisheries 25: 425–447.

Tanaka, K.D. 2015. A color to birds and to humans: why is it so different? J Ornithol 156 S1: 433-440.

Vorobyev M. & D. Osorio. 1998. Receptor noise as a determinant of color thresholds. Proc R Soc Lond B 265: 351–358.