HAMILTON BIOLOGICAL

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## SUBJECT: REVIEW OF PERMITTING HISTORY AND BIOLOGICAL JUSTIFICATIONS GIVEN FOR LIGHTING THE BAY BRIDGE

Dear Mr. Baker,

At your request, and in support of the legal action that you are taking to require CEQA review of The Bay Lights 360 project (Mark Baker v. Bay Area Toll Authority [BATA] et al.), I provide this professional evaluation of (a) the permitting processes that have been followed by governmental agencies responsible for evaluating and approving the installation of decorative LED lighting on the San Francisco-Oakland Bay Bridge, and (b) the biological justification for the latest LED light installation, provided by HT Harvey & Associates in the attached memorandum dated March 23, 2024, entitled "Final Assessment of the Potential Impacts of The Bay Lights 360 Project on Birds and Fish." This memorandum, prepared by Sharon Kramer, Scott Terrill, and Sophie Bernstein of HT Harvey & Associates for David J. Powers & Associates, is hereafter referred to as the HT Harvey memorandum or simply the memorandum. My qualifications to conduct this review are provided in the attached curriculum vitae.

## THE BAY LIGHTS AND THE BAY LIGHTS 360 PROJECTS

According to The Bay Lights web page (https://illuminate.org/projects/thebaylights/), The Bay Lights was permitted as a temporary, two-year installation by a group called Illuminate the Arts. The project involved installing 25,000 LED lights along 1.8 miles of the two-mile-long West Span of the bridge from March 5, 2013 until their removal in 2015. Starting on January 30, 2016, a new 501(c)(3) group called Illuminate fitted the Bay Bridge with 25,000 new LED lights that were reported to be "brighter" than those used in the previous installment. A memorandum prepared by David J. Powers & Associates, dated June 29, 2023, entitled "Technical Memorandum – Visual Assessment, The Bay Lights 360," describes The Bay Lights 360 project:

> The proposed Project [following removal of the lights in 2023] consists of three main components: (1) the extension of the light sculpture for another 10 years to 2033; (2) the replacement of the light fixtures with newly updated and more robust fixtures and components while keeping the same technical details and intensity of the lights as the current installation; and

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> (3) the addition of light fixtures to the driver's (inward-facing) side of the same suspension cables for a 360-degree view of the light sculpture.
>
> . . .
>
> Forty-eight thousand (48,000) energy-efficient LED lights, approximately 1.75″ x 2.75″ each, will be installed. The LED lights will be secured to the vertical suspension bridge cables at the full height of the suspension cables at one-foot spacing. The lights will be attached to the outward-facing side (north-facing side only) of the bridge suspension cables with ultraviolet (UV) resistant, heat-stabilized nylon black zip ties at six-inch intervals, so no paint disturbance will occur to the bridge structure and no repainting is needed. The light temperature will be 4,000 kelvin and the brightness will be 87 lumens (at 100-percent brightness) for all fixtures, consistent with the existing lighting. Light fixtures can be replaced individually, if needed.
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> . . .
>
> The proposed new The Bay Lights 360 will be visible from all directions (360-degree view) and will be lit from dusk to dawn for 10 years. The light strands on both sides of the cables can be turned off or dimmed independently of each other with their own separate controls. The light fixtures can also be physically adjusted (rotated).
>
> The light display will be controlled by the artist and will appear to be moving in a wave-like and alternating flickering nonrepeatable but abstract pattern, consistent with the existing lighting.

The following photos give an indication of the magnitude and intensity of light provided along the 1.8-mile length of the project, and provide a comparison with lighting conditions on the bridge in 2023, during the period when The Bay Lights had been turned off.

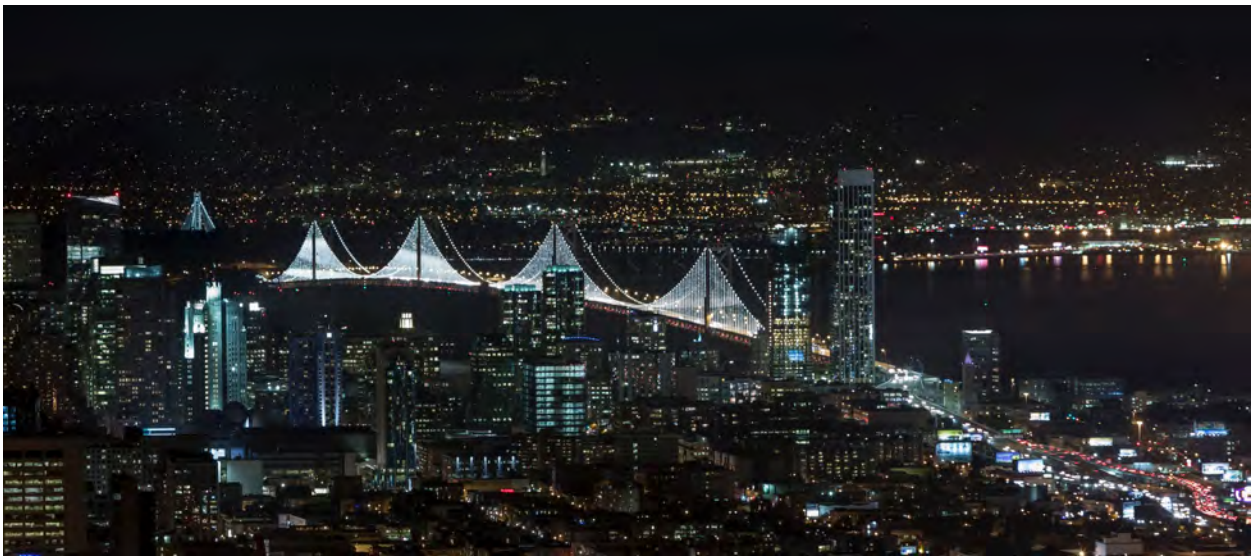

**Figure 1.** This photo, posted on the web page of Leo Villareal (the artist responsible for the bridge lighting project) shows the original installation of The Bay Lights in 2013 (https://villareal.net/the-bay-lights-2013-the-bay-bridge-sf-ca). The lighting occupies 1.8 miles of the bridge's West Span, between San Francisco and Yerba Buena Island.

**Figure 3.** Photo from the *New York Times* taken in March 2023, showing the Bay Bridge during the period when The Bay Lights had been turned off. The decorative lights on the suspension cables were added in 1986[1]. Although the bridge was lit, as necessary for public safety, the amount of sky-glow was clearly far lower than when The Bay Lights had been in operation.

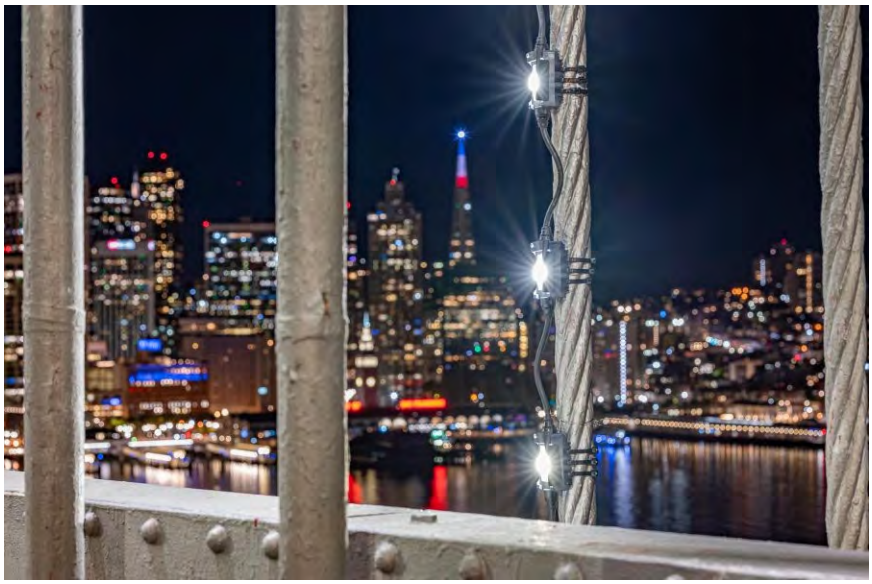

**Figure 4.** This photo, posted on the web page of Illuminate, the organization responsible for the bridge lighting project, shows three of the new 4,000-kelvin LED lights installed on the Bay Bridge in late 2024[2].

The first part of this letter reviews the permitting processes that have been followed to allow for implementation of The Bay Lights and The Bay Lights 360 projects, and the second part reviews the HT Harvey memorandum.

[1] https://www.sfgate.com/default/article/Bay-Bridge-to-beam-vivid-light-sculpture-3872898.php
[2] https://illuminate.org/2024/12/09/a-first-look-the-bay-lights-installation-crews-are-hard-at-work/

## BATA-Issued Notice of Exemption from CEQA

On June 8, 2012, BATA issued to Caltrans a Notice of Exemption (NOE) from CEQA for The Bay Lights project. This 2012 NOE was cited in BCDC Permit M2012.009 and all subsequent amendments, including the fourth and most recent. I do not possess a copy of the 2012 NOE, but attached to this letter is a copy of the most recent NOE, dated August 15, 2023, which BATA produced for The Bay Lights 360 project.

In issuing a Class I exemption, BATA's 2023 NOE cites Section 15301 of CEQA:

> **Section 15301 – Existing Facilities.** Class 1 consists of the operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of existing or former use.

The transmutation of the West Span of the Bay Bridge from utilitarian public infrastructure to a vast LED display screen upon which a privately funded group exhibits nightly, computerized light shows, does not represent "negligible or no expansion of existing or former use" of the bridge. The change is clearly substantial and, as discussed in this letter, could result in significant adverse effects upon native wildlife populations.

The 2023 NOE claims that increases in the number and intensity of LED lights installed on the bridge, and the change from a "temporary" to a "permanent" installation, do not materially change the previously granted exemption:

> **Reasons why project is exempt:** The project is the extension of the light sculpture for another 10 years, removal and re-installation of the existing LED lights, and the addition of new lights on the driver's side of the same suspension cables to allow a 360-degree view of the LED light structure. The addition of the LED lights is considered a negligible expansion as the existing lights are already a prominent feature on the Bay Bridge and the hours of operation would remain the same.

This is circular logic: BATA granted the project an unwarranted exemption from CEQA in 2012, then granted another exemption in 2023 because "the existing lights are already a prominent feature." Because CEQA review has never been undertaken for any of the iterations, BATA has no basis for determining that these installations have not resulted in significant adverse effects to the environment.

**CEQA Section 15300.2(b):** "All exemptions for these classes are inapplicable when the cumulative impact of successive projects of the same type in the same place, over time is significant." The current installation of 48,000 high-intensity LEDs on the West Span, considered together with the 48,000 high-intensity LEDs installed on the East Span of the Bay Bridge under the seismic safety project completed in 2013 (also without CEQA review), represent "successive projects of the same type in the same place, over time." The best available scientific information indicates that these projects, considered together over time, likely have significant adverse effects on populations of native wildlife species that migrate aerially at night. Thus, the CEQA categorical exemption is inapplicable.

**CEQA Section 15300.2(c):** "A categorical exemption shall not be used for an activity where there is a reasonable possibility that the activity will have a significant effect on the environment due to unusual circumstances." An art installation consisting of 48,000 LEDs on a bridge over San Francisco Bay represents an unusual circumstance, or at least one that could not have been anticipated until recent years, when the technology to implement such a project first became available. Extensive scientific literature points to a likelihood that the Bay Bridge lighting projects—which have never been evaluated in the field and which incorporate no preventative mitigation features, such as using less damaging light temperatures, turning the lights off during peak migration periods, or cutting the lights off after a certain hour of the night—are having significant adverse effects upon populations of native birds, bats, and insects. In fact, Caltrans in 2019 commissioned a review by CTC & Associates entitled *Assessing the Impacts of LED Lighting to Wildlife*. This 34-page document, attached to this letter and posted at Caltrans' web site[3], contains summaries of numerous recent scientific studies pointing to the known impacts of LED lighting to various forms of wildlife. I discuss the results and implications of multiple relevant studies in my review of the HT Harvey memorandum.

For all of these reasons, BATA lacked adequate basis, factual or inferential, upon which to issue an NOE for The Bay Lights project in 2012 and another NOE for The Bay Lights 360 project in 2023.

## REVIEW OF BCDC PERMIT M2012.009

On August 7, 2012, the San Francisco Bay Conservation and Development Commission (BCDC) issued permit M2012.009 to Caltrans, allowing for the initial "temporary" installation of 25,000 LED lights from 2013 to 2015. I have reviewed aspects of the original permit in relation to the relevant controlling statutes and policies. The four amendments to permit M2012.009 are considered thereafter.

### "Minor Repair or Improvement"

Page 3 of permit M2012.009 contains the following Findings and Declarations.

> **III. Findings and Declarations**
>
> On behalf of the Commission, I find and declare that:
>
> A. **Minor Repair or Improvement**. The project authorized by this permit involves the temporary installation of a light sculpture on the Bay Bridge, a structure in the Bay. The project therefore, involves minor fill in the Bay for improving shoreline appearance that complies with section 10700 that does not exceed 1,000 square feet, as defined by Commission Regulation 10601(a)(7), and therefore, is a "minor repair or improvement" for which the Executive Director may issue a permit, pursuant to Government Code Section 66632(f) and Regulation Section 10622(a).

[3] https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/preliminary-investigations/assessing-the-impacts-of-led-lighting-to-wildlife-pi-a11y.pdf

The BCDC Regulations are provided in the California Code of Regulations, Title 14, Division 5. Section 10700, cited above, is excerpted below.

§ 10700. Minor Fill for Improving Shoreline Appearance.

Currentness

The Commission may approve the placement of minor fill to improve shoreline appearance, including the mooring of an historic ship as defined in Section 10703 or the repair, maintenance, renovation, remodeling, rehabilitation, or replacement of a pre-existing residential structure as defined in Section 10705, only if, in addition to the other findings required by Cal. Government Code Section 66605 and the San Francisco Bay Plan, the Commission finds and declares that:

(a) the fill is necessary because:

(1) the present appearance of the Bay and shoreline in the area adversely affects enjoyment of the Bay and its shoreline within the site area itself or within adjacent areas of the Bay or shoreline, and

(2) it is either physically impracticable or economically infeasible to improve the appearance without filling;

(b) the amount of filling approved is the minimum necessary to improve shoreline appearance;

(c) the proposed project would improve the shoreline appearance; and

(d) the fill will not adversely affect enjoyment of the Bay and its shoreline within the fill area itself or within adjacent areas of the Bay and shoreline and the fill will not have any adverse effect on present or possible future use of the area for any designated priority water-related use or for public access, and

(e) with regard to a pre-existing residential structure, the requirements of subdivisions (b) and (c) above will be deemed met if (i) the repair, maintenance, rehabilitation, renovation, remodeling or replacement will not substantially enlarge the size of the pre-existing structure, (ii) will not be out of character or scale with any nearby structures, (iii) will cover no more of the Bay surface than the pre-existing structure, and (iv) will not change the use of the pre-existing structure.

Thus, Section 10700 regulates *the placement of fill* in the Bay. Section 66632 of the McAteer-Petris Act defines "fill" as follows:

> For purposes of this title, "fill" means earth or any other substance or material, including pilings or structures placed on pilings, and structures floating at some or all times and moored for extended periods, such as houseboats and floating docks.

The Bay Lights project, and its successor projects, involve no placement of fill in the Bay, and thus **Section 10700 is not applicable.**

Permit M2012.009 also cites Commission Regulation 10601(a)(7) as part of the justification for approval. This regulation is excerpted in context below.

§ 10601. Minor Repairs or Improvements.

Currentness

"Minor repairs or improvements" means any activity for which a Commission permit is required, that is either (a) necessary to the health, safety, or welfare of the public in the entire Bay Area, (b) consistent with the Government Code sections 66600 through 66661 and the San Francisco Bay Plan, or (c) consistent with the Public Resources Code sections 29000 through 29612 and Suisun Marsh Protection Plan or with the certified Suisun Marsh Local Protection Program, and that falls into one or more of the following categories:

(a) with respect to activities in San Francisco Bay and areas within the Commission's "certain waterways" jurisdiction:

(1) the construction of a new single boat dock and associated docking facilities (such as lifts, gangways, and pilings) no larger than 1,500 square feet or a new multiple boat dock and associated facilities no larger than 5,000 square feet, or up to 20,000 square feet of expansion of boat docking facilities within an existing marina;

(2) the installation of new shoreline protective works and repairs to protective works, such as bulkheads, levees, natural or nature-based features, and riprap, that meet the following criteria:

(A) the size of the new work(s) or the repairs to the existing work(s) constitute the minimum amount of fill necessary to stabilize existing dikes and banks or to provide improved fish or wildlife habitat, and

(B) the new work or repairs to existing work(s) would cover less than 10,000 square feet of the Bay or a certain waterway;

(3) the placement of piles to support extensions of portions of principal structures, as defined in section 10702(b), over the water where the total of any such extensions would not exceed 1,000 square feet in area;

(4) the placement of outfall pipes approved by the California Regional Water Quality Control Board, San Francisco Bay Region;

(5) the placement of utility cables or pipelines on or under the bottom of the Bay or a certain waterway;

(6) routine repairs, reconstruction, replacement, removal, or maintenance of a structure that do not involve any substantial enlargement or change in use;

(7) minor fill for improving shoreline appearance that complies with section 10700 and that does not exceed 1,000 square feet in area;

(8) minor fill for improving public access that complies with section 10701 and that does not exceed 5,000 square feet in area;

(9) habitat restoration or enhancement activities that would not exceed 20,000 square feet in the Bay or a certain waterway, would include the minimum amount of fill necessary to improve wildlife habitat, and would not have significant adverse habitat conversion impacts; and

(10) extraction or dredging of no more than 10,000 cubic yards of materials to enhance tidal connectivity or restore habitat or the disposal of such materials within an existing site for such purposes.

The placement of lights on the bridge is categorically different than placement of fill in the Bay (*cf.* Section 66632 of the McAteer-Petris Act), and **therefore 10601(a)(7) is not applicable.**

## Consistency with McAteer-Petris Act

On the original permit, Paragraph B under Findings and Declarations states:

> B. **Consistency with McAteer-Petris Act and San Francisco Bay Plan**. The project authorized by this permit is consistent with the McAteer-Petris Act and with the San Francisco Bay Plan in that the project will not adversely affect the Bay nor public enjoyment of the Bay. Special Condition II-B has been included to assure that installation and dismantling activities will be conducted in such a manner that will minimize adverse impacts to birds by limiting work to times when birds are not likely to be present and by requiring monitoring during construction by a trained ornithologist. Special Condition II-B also requires that the permittee prevent construction debris from entering the Bay in order to protect Bay water quality and navigation, consistent with the Bay Plan's policies on these subjects.

Contrary to these findings, the placement of tens of thousands of decorative LED lights on an existing structure in the Bay, without legitimate environmental review, violates section 66604 of the McAteer-Petris Act, excerpted below.

**66604.** Findings and Declarations as to Maximum Protection of Present Shoreline and Body of Bay

> The Legislature further finds and declares that in order to protect the present shoreline and body of the San Francisco Bay to the maximum extent possible, it is essential that the commission be empowered to issue or deny permits, after public hearings, for any proposed project that involves placing fill, extracting materials or making any substantial change in use of any water, land or structure within the area of the commission's jurisdiction.

Creating a massive LED display screen on the West Span of the Bay Bridge upon which nightly light shows are exhibited from dusk to dawn represents a "substantial change" to this structure. The decision of the BCDC to issue a permit and four successive amendments allowing for this novel, and increasingly expansive, change in the use of this structure, in the absence of CEQA environmental review, does not protect San Francisco Bay "to the maximum extent possible." Thus, BCDC permit M2012.009 and subsequent amendments clearly conflict with this core tenet of the McAteer-Petris Act.

## Consistency with Coastal Zone Management Act

In the original permit, paragraph C under "Findings and Declarations" states:

> C. **Coastal Zone Management Act.** The Commission further finds, declares, and certifies that the activity or activities authorized herein are consistent with the Commission's Amended Management Program for San Francisco Bay, as approved by the Department of Commerce under the Federal Coastal Zone Management Act of 1972, as amended.

Contrary to this finding, the placement of tens of thousands of decorative LED lights on an existing structure in the Bay, without adequate environmental review, conflicts with the Management Program for San Francisco Bay in multiple ways, as discussed below.

**Page 12** of the Management Program for San Francisco Bay states:

> (2) **Biological and Physical Considerations**
>
> Though the boundary of the BCDC segment of the coastal zone differs from that for the remainder of the coastal zone, the fundamental considerations in determining the BCDC boundary were the same as those used in determining the Coastal Management segment: the biological and physical characteristics of the coastal zone. During the planning process from 1965 to 1969, the Commission made detailed studies of the Bay and adjacent shore lands. From these studies, the Commission concluded that nearly all development activities in the Bay itself or in adjacent shorelands—the salt ponds, the marshes, the managed wetlands, and the adjacent shoreline—would have direct and significant biological and physical impacts on the Bay, and therefore all development should be regulated by the State through the BCDC. The Commission, therefore, recommended that its permit jurisdiction include all of these areas. This recommendation was accepted by the Legislature and enacted into law through amendments to the McAteer-Petris Act in 1969. The Legislature also subsequently gave the Commission jurisdiction over the ecologically important portions of major tributaries to the Bay, except for the Sacramento and San Joaquin Rivers. For permit purposes, these tributaries are treated the same way as the Bay itself.

There is no basis to believe that the "detailed studies" referred to above included evaluating the effects of LED light pollution on wildlife populations, because such studies had yet to be carried out in the 1960s, but the generalized conclusion "that nearly all development activities in the Bay itself . . . would have direct and significant biological and physical impacts on the Bay" certainly suggests that discretionary projects involving massive additions of light to an existing structure in the Bay, at a time when the adverse effects of LED light on wildlife are becoming increasingly recognized, warrant careful environmental review and identification of measures designed to mitigate any potentially significant adverse effects to wildlife populations.

**Page 21** of the Management Program for San Francisco Bay states:

> b. **Areas for Preservation and Restoration**
>
> (1) **The Bay Itself**
>
> The Bay Plan policies state the open water of the Bay should be preserved to the maximum feasible extent and filling should be limited to the minimum necessary for the high-priority, water-oriented uses specified in the McAteer-Petris Act and the Bay Plan. Before a permit can be issued for any project, the Commission must find that the project is consistent with this policy.

Although limiting the placement of fill in the Bay was an overriding conservation priority in the 1970s, it is relevant that the Management Program identified "The Bay Itself" as the No. 1 "area for preservation and restoration." Decades later, light pollution has become widely recognized as an important resource-management issue everywhere. Thus, protecting the Bay and associated natural resources from ever-expanding LED light pollution should be a conservation priority fully considered during environmental

review of massive, discretionary projects like The Bay Lights and The Bay Lights 360. As discussed subsequently in this letter, the California Department of Fish and Wildlife (CDFW) emphasized the importance of limiting light pollution in and around San Francisco Bay in their 2021 review of the Draft EIR for *Plan Bay Area 2050*.

**Page 25** of the Management Program for San Francisco Bay states:

> b. **The National Interest in San Francisco Bay**
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> In addition to considering the national interest in its planning for the Bay from 1965 to 1969, and in its planning for the Suisun Marsh from 1974 to 1976, the Commission has also attempted to define the national interest in the Bay specifically for the purpose of the Coastal Zone Management Act. This definition is in the form of a statement entitled "The National interest in San Francisco Bay," which has been circulated to those Federal agencies that appear to have an interest in San Francisco Bay. It is being included in the BCDC Management Program at this time to meet the specific requirements of the Coastal Zone Management Act and related regulations. It reads as follows:
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> "**San Francisco Bay is a National Resource**. San Francisco Bay is of more than local or even State importance; it is a resource of national significance. Visitors from across the country can enjoy the scenic beauty and recreational facilities of the Bay. Foreign goods bound for consumers in inland states, and United States products on their way to distant countries, pass through Bay Area ports. The Bay is also the largest tidal estuary on the West Coast and provides wildlife habitat of nationwide importance, particularly in and around the Suisun Marsh.

Given the "national significance" of San Francisco Bay as a natural resource placed in the public trust, how is it possible that a small, privately funded group has been able to repurpose 1.8 miles of the Bay Bridge as the medium for their nightly light shows without these actions undergoing any formal environmental review?

**Page 26** of the Management Program for San Francisco Bay states:

> "**The Federal Coastal Zone Management Act.** Recognizing the distinct and irreplaceable value of this country's entire coastline as a national resource, the United States Congress enacted the Coastal Zone Management Act of 1972 (PL 92-583), which states, '…it is national policy…to restore or enhance, the resources of the nation's coastal zone for this and succeeding generations' (Section 303(e)). This language, to a considerable degree, indicates an objective similar to the pioneering efforts of California in creating the San Francisco Bay Conservation and Development Commission (BCDC), the agency which since 1969 has been carrying out the San Francisco Bay Plan, and which since 1976 has been carrying out the Suisun Marsh Protection Plan. Together these two plans form the core of California's management program for San Francisco Bay.

More than five decades ago, when the Federal Coastal Zone Management Act went into effect, the San Francisco Bay area was placed under the jurisdiction of the BCDC, which already existed at that time, while the rest of the state's Coastal Zone was placed under

the jurisdiction of the nascent California Coastal Commission (CCC). Since then, the CCC has developed and enacted a range of strong policies designed to protect sensitive coastal resources, and the CCC maintains a staff that includes ecologists and other specialists help ensure proper enactment of those policies in compliance with the Federal Coastal Zone Management Act (and the California Coastal Act). By contrast, the BCDC lists no biologists or ecologists on its staff roster (https://bcdc.ca.gov/about/staff-roster/), and thus the Commission lacks the expertise required to conduct an in-house review of The Bay Lights project. The 2023 HT Harvey memorandum refers to a 2011 "Technical Memo" that was apparently prepared prior to installation of The Bay Lights project in 2013, but the References section of their 2023 memorandum does not cite the 2011 Technical Memo. A copy of the 2011 document was not included in the administrative record that I reviewed. In any case, The Bay Lights project did not undergo CEQA review because BATA has issued two unwarranted Notices of Exemption to Caltrans (see pages 4 and 5 of this letter). The lack of any light-related mitigation measures for any of the Bay Bridge light projects implies that these projects have never been subjected to a formal environmental review process.

By contrast, consider the 2003 proposal by Caltrans District 7 to add decorative lighting to the Vincent Thomas Bridge in Los Angeles County. That project was also (incorrectly) granted a CEQA Notice of Exemption, and although the potential adverse effects of lighting upon wildlife had not been studied as intensively 22 years ago as they have been today, the CCC nevertheless subjected the proposed actions to a legitimate, formal environmental review process and added to the project's Coastal Development Permit special conditions protective of organisms sensitive to artificial light:

- During the fall (August and October) and spring (March through May) migratory bird periods the lights shall be operated only between the hours of sunset and 11:00 p.m.

- The applicant shall agree in writing, subject to the review and approval of the Executive Director, if any significant mortality of birds is observed, the lights shall be turned off immediately until the Coastal Commission, California Department of Fish and Game, and the US Fish and Wildlife Service are notified and an appropriate course of action is identified by the three agencies. The course of action may include the permanent discontinuation of the lights. Based on the course of action identified by the agencies, the Executive Director shall determine if an amendment to this permit is required.

Under these conditions, imposed by the CCC, the project was implemented in 2005, and the decorative lights on the Vincent Thomas Bridge have thereafter remained operational in legitimate compliance with the Federal Coastal Zone Management Act. Years later, in considering a series of ever-larger and more intensive lighting projects on the Bay Bridge, the BCDC has repeatedly refused to undertake a formal environmental review process or impose any protective measures. Nevertheless, with each new variant

of The Bay Lights project, the BCDC finds itself to be in compliance with the Federal Coastal Zone Management Act.

**Page 53** of the Management Program for San Francisco Bay states:

> (2) **The Department of Fish and Game**
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> The Department of Fish and Game is concerned with all Bay activities that might affect the fisheries or wildlife habitat of the Bay. Consequently, although part of the Resources Agency, the Department has a special relationship to the Commission and comments on the fish and wildlife aspects of all permits. These comments become the basis for special conditions relating to mitigation of adverse impacts on fish and wildlife resources, and on occasion, for denial of a permit where warranted. Furthermore, the Department and the Commission worked closely together to prepare the Suisun Marsh Protection Plan.

Despite the "special relationship" between the Commission and the CDFW (the successor agency to the Department of Fish and Game), **BCDC permit M2012.009 contains no input from CDFW biologists concerning potential adverse effects of night lighting on wildlife.** Instead, in the original permit and the four amendments, CDFW has focused solely on the potential for workers to disrupt birds attempting to nest on the bridge (although birds are considered highly unlikely to nest on the Bay Bridge West Span vertical suspender cables due to the lack of horizontal surfaces). CDFW biologists are, however, well aware of the literature describing the adverse effects of lighting on wildlife. See, for example, the attached letter from CDFW to the Metropolitan Transportation Commission (MTC) dated July 13, 2021, commenting on the *Plan Bay Area 2050* Draft EIR. Pages 5–7 of CDFW's letter, excerpted below, address the topic of light pollution and methods for avoiding and mitigating potentially significant impacts:

> **Light Pollution Analysis, Avoidance and Minimization**
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> Light pollution has the potential to significantly and adversely affect biological resources because unlike the natural brightness created by the monthly cycle of the moon, permanent and continuously powered lighting fixtures create an unnatural light regime producing a constant light output. Continuous light output for 365 days a year can have a cumulatively significant impact on fish and wildlife populations. CDFW strongly recommends reducing artificial light outputs within the Project limits to avoid potentially significant impacts from light pollution.
>
> Night lighting can disrupt the circadian rhythms of many species. Many wildlife species use photoperiod cues for communication (e.g., bird song; Miller 2006), determining when to begin foraging (Stone et al. 2009), behavior thermoregulation (Beiswenger 1977), and migration (Longcore and Rich 2004). Artificial night lighting has also been found to impact juvenile salmonid overwintering success by delaying the emergence of salmonids from benthic refugia and reducing their ability to feed during the winter (Contor and Griffith 1995).
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> To adequately describe the project and reduce impacts to less-than-significant, CDFW recommends that the Draft EIR include the analysis and Mitigation Measures 1-5 below.
>
> Analyze currently existing light sources output within proposed Project limits. Reduce or remove the number of light sources proposed within Project corridors such as informational signs, bicycle/pedestrian access light sources and overhead light poles. Reduction in the number of light output sources can be accomplished by increasing the standard spacing from light pole source to light pole source within the Project limits and by avoiding light source installation in highly sensitive resource locations. In addition,

utilizing light shielding, light output restrictions and measures discussed in detail below may reduce the potentially significant impacts created by artificial lighting sources.

1. The lead agency shall provide Isolux Diagrams that analyze current light levels present during pre-Project conditions and provide the predicted Project light levels that will be created upon completion of the Project. The analysis shall include an analysis of all potential light sources proposed for new install or replacement. Upon Project completion the lead agency shall conduct a ground survey that compares current and predicated light levels with actual light levels achieved upon completion of the Project through comparison of Isolux diagrams. If an increase from the projected levels to the actual levels is discovered additional avoidance, minimization or mitigation measures may be required and shall be implemented in coordination with CDFW.

2. All LEDs or bulbs installed as a result of the Project shall be rated to emit or produce light at or under 2700 kelvin that results in the output of a warm white color spectrum.

3. Solid concrete barriers at a minimum height of 3.5 feet should be installed in areas where they have the potential to reduce illumination from overhead lights and from vehicle lights into areas outside of the roadway. Barriers should only be utilized as a light pollution minimization measure if they do not create a significant barrier to wildlife movement. Additional barrier types should be employed when feasible, such as privacy slats into the spacing of cyclone fencing to create light barriers for areas outside the roadway.

4. Retro-reflectivity of signs and road stripping shall be implemented throughout the Project to increase visibility of roads to drivers and reduce the need for electrical lighting. Reflective highway markers have also been proven effective to reduce raptor collisions on highways in California's central valley if installed along highway verges and medians.

5. All light poles or sources of illumination that are new or replacement installations shall be installed with the appropriate shielding to avoid excessive light pollution into natural landscapes or aquatic habitat with the Project corridor in coordination with the natural resource agencies. In addition, the light pole arm length and mast heights should be modified to site specific conditions to reduce excessive light spillage into natural landscapes or aquatic habitat within the Project corridor. In areas with sensitive natural landscapes or aquatic habitat, placing light poles at non-standard intervals shall occur to further reduce the potential for excessive light pollution by decreasing the number of light output sources.

CDFW's 2021 letter describes the dangers of different types of lights on wildlife in the Bay Area, identifies lights as having "the potential to significantly and adversely impact biological resources," identifies five mitigation measures to avoid or reduce the severity of light impacts, and states, **"CDFW strongly recommends reducing artificial light inputs within the Project limits to avoid potentially significant impacts from light pollution."** Why, then, has this public agency remained silent for more than a decade regarding (a) the unwarranted CEQA Notices of Exemption issued to Caltrans by BATA, and (b) the lack of special conditions on BCDC permit M2012.009 and four amendments?

In the five specific ways described above, the hands-off approach of both BCDC and CDFW toward the permitting of repeated large-scale installations of tens of thousands of LED lights on the Bay Bridge, over more than a decade, without identifying any light-related mitigation measures, conflicts with fundamental tenets of the Federal Coastal Zone Management Act.

## Review of Amendments to BCDC Permit M2012.009

I have reviewed the four amendments that the BCDC has issued to permit M2012.009. This section reviews specific language in some of these amendments that sheds further light on the negligent, and seemingly dishonest, approach the responsible agencies have taken toward the ongoing consideration of multiple LED light installations under The Bay Lights and The Bay Lights 360 projects.

### Amendment No. 1, September 14, 2014

This amendment granted a time extension to Caltrans to operate the original installation of The Bay Lights project through January 31, 2015. I have no comments on this amendment.

### Amendment No. 2, through January 26, 2015

This amendment granted a time extension to Caltrans to operate the original installation of The Bay Lights project through March 6, 2015, and required the lights to be removed by July 15, 2015. Because this required work during the nesting bird season, this amendment required an avian monitor to be present weekly to search for nests.

Page 5 of the amendment states, "input from the U.S. Fish and Wildlife Service Migratory Bird Program that birds are highly unlikely to nest on the Bay Bridge West Span vertical suspender cables due to the lack of horizontal surfaces." Thus, the focus of the CDFW on avoiding potential project effects on nesting birds—reflected in the conditions placed on the original permit and each successive amendment—while remaining silent regarding the potential adverse effects of the lights on birds, bats, and insects, appears to represent an effort by that agency to "give the appearance of doing something" while taking no action to address or even evaluate the actual problem.

### Amendment No. 3, through June 1, 2015

This amendment authorizes the re-installation, operation, and maintenance of "the originally authorized light sculpture for ten-years, illuminating the sculpture from January 2016 through January 2026." The amendment also authorizes Caltrans to replace the existing roadway lights with LED lights. Again, the only biological mitigation required involved the timing of the installation and the need for a biological monitor if work was to take place during the bird nesting season.

Item C on page 4 states: "To reduce light emissions and resultant impacts to migratory birds and increase energy efficiency, the permittee shall replace all existing roadway light bulbs with LED bulbs by June 30, 2016 (Amendment No. Three)." The amendment

provides no factual support for the assertion that replacing the then-existing roadway light bulbs with unspecified LED bulbs would reduce impacts to migratory birds.

Page 5 of the amendment offers the following rationales for continuing the reconstituted project for another ten years:

> 2. **Amendment No. Three.** Amendment No. Three authorizes the re-installation of the originally authorized light-sculpture and the illumination of the sculpture for a ten-year period. The bridge is a water-oriented use defined in Section 10605 of the McAteer-Petris Act. Several of the Bay's bridges have decorative lights to enhance night time views of these iconic Bay structures (e.g., the Golden Gate Bridge, the new east span of the Bay Bridge). Because the light display will be located on an existing bridge, the Bay's volume and surface area will not be reduced or impaired with the project. The re-installation and operation of the sculpture for a ten-year period is similar to, with no greater adverse impact to the Bay, as defined by Regulation Section 10601(e)(3), to the placement of minor fill for improving public access, consistent with Regulation Section 10601(a)(8) and is thus considered a "minor repair or improvement" for which the Executive Director may issue an amendment to an existing permit pursuant to Government Code Section 66632(f) and Regulation Section 10622(a).

The acknowledged presence of decorative lights on "several of the Bay's bridges" highlights the fact that these purely discretionary bridge-lighting projects represent a cumulatively considerable impact on biological resources. Although the best available scientific information indicates a likelihood that these projects, considered independently or cumulatively, are having significant adverse effects upon various forms of wildlife, unwarranted categorical exemptions have shielded Caltrans from the normal requirement to conduct CEQA review of these projects. As detailed herein, the failure of the BCDC to regulate these projects violates both the McAteer-Petris Act and the Coastal Zone Management Act.

The paragraph also notes, "the Bay's volume and surface area will not be reduced or impaired with the project," which reflects the fact that the project does not involve the placement of fill. Nevertheless, the paragraph goes on to claim that the lighting project "is similar to, with no greater adverse impact to the Bay, as defined by Regulation Section 10601(e)(3), to the placement of minor fill." As discussed previously in this letter, the regulatory comparison of a nightly LED light show on the West Span of the Bay Bridge to "the placement of minor fill" is a non-sequitur. A large body of scientific evidence indicates that the "adverse impact to the Bay" from massive LED lighting is much greater than would accompany any minor placement of fill in the Bay.

Finally, since this amendment simply reauthorized re-installation, operation, and maintenance of "the originally authorized light sculpture," it is unclear why discrepancies exist in the various descriptions of the number and brightness of the LEDs that were installed under this amendment. For example, the HT Harvey memorandum

states that this second installation consisted of 30,000 lights instead of the 25,000 originally authorized and installed.

## Amendment No. 4, through September 7, 2023

This current amendment authorizes the removal of the "Bay Lights" and installation of 48,000 LEDs for the "Bay Lights 360," which is permitted to operate through December 31, 2033. The new project includes "updated and more robust fixtures and components and adds lights to the roadway-facing side of the same suspension cables to create a 360-degree view of the light sculpture."

This amendment, like the previous ones, focuses on preventing potential adverse effects on nesting birds, despite BCDC's previous acknowledgment that "birds are highly unlikely to nest on the Bay Bridge West Span vertical suspender cables due to the lack of horizontal surfaces."

This amendment also repeats the same rationales for why The Bay Lights 360 should be permitted without CEQA review or any other formal environmental review. New in the fourth amendment, however, is a remarkable admission on page 9 that Caltrans had commissioned a report identifying potentially significant adverse effects of LED lighting on the environment:

> A report commissioned by Caltrans, dated April 2023, summarizing the existing research on the effects of LED lights on terrestrial wildlife found that the color, intensity, and special characteristics such as flicker of LED lights have the potential to disrupt migration patterns of birds, bats, and insects. However, a biological memo assessing the likely impacts of the project concluded that the sculpture is not expected to significantly adversely impact the Bay or wildlife species given the existing high levels of ambient light on the Bay Bridge and roadway and the low levels of light expected to reach the water. As a result, no special conditions have been required to mitigate for light impacts, but in considering any future requests to extend the authorization for the project, the Commission should take into account the most current research on the impacts of LED lights in consultation with the appropriate wildlife agencies.

As discussed on page 3 of this letter, and later in my review of the HT Harvey memorandum, Caltrans has been accumulating scientific information on the adverse effects of LED lighting on wildlife since at least 2019, when the agency commissioned the 34-page review by CTC & Associates entitled *Assessing the Impacts of LED Lighting to Wildlife*. Nevertheless, Caltrans continued to receive from BATA Categorical Exemptions from CEQA—to install tens of thousands of high-intensity LEDs on the Bay Bridge without any special conditions to mitigate for light impacts—receiving the latest one on August 15, 2023.

The "April 2023" Caltrans report referred to in the fourth permit amendment, *Effects of LED Lighting on Terrestrial Wildlife*[4], is a 189-page scientific review by Travis Longcore, a pioneer in the study of the effects of night-lighting on living organisms. He reviewed 342 discrete studies conducted in the field and in laboratory settings on the effects of LEDs on terrestrial wildlife. I will address this report in my review of the HT Harvey memorandum, but quote here only the last part of the Abstract:

> Current research supports the mitigation of LED impacts by reducing intensity, controlling spill, reducing duration, and controlling spectrum to avoid peak sensitivities of most groups to shorter wavelengths. Significant variability in photoreceptor sensitivity and flexibility of spectral outputs of LEDs argue for the consideration of specific affected species for efforts to mitigate adverse impacts from LEDs.

The BCDC's rationale for continuing to ignore the potential adverse effects of LED lights on wildlife is provided in the unattributed and undated "biological memo" cited on page 9 of the fourth amendment. Presumably, this refers to the 11-page HT Harvey memorandum dated March 24, 2023 (which I review herein), although it might also refer to the 2011 "Technical Memo" referred to obliquely in the 2023 memorandum.

Finally, it is relevant to consider that the fourth amendment, authorizing The Bay Lights 360, is identified on the BCDC web page as a "non-material amendment." This means that the BCDC's Executive Director determined that the project is not "large in scope" and does not present "significant potential impacts to the Bay," either of which would require the issuance of a "material amendment." As stated on the BCDC's web page:

> The key difference between applying for a material and non-material permit amendment is that a non-material permit amendment is issued by BCDC's Executive Director and the project typically does not need to be voted on by the Commission.

The Bay Lights 360, with a budget of $11 million, is objectively "large in scope," and it clearly does entail "significant potential impacts to the Bay," and therefore this project should not have been granted a non-material amendment. By granting the amendment anyway, the Executive Director has approved, for ten years, the current installation of 48,000 high-intensity LEDs across 1.8 miles of the West Span of the Bay Bridge without identifying any special conditions to mitigate the range of potentially significant adverse effects of LED lights on wildlife that have been extensively documented by researchers over a period of decades. One important reason for subjecting large, potentially damaging projects like this to CEQA review is to prevent this type of abuse of discretion.

[4] https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/final-reports/ca23-3696-finalreport.pdf

# REVIEW OF THE HT HARVEY MEMORANDUM

As discussed previously, the HT Harvey memorandum to David J. Powers & Associates, dated March 24, 2023, provides an evaluation of potential effects of The Bay Lights 360 project on fish and birds. I am an avian biologist and limit my review to the avian portion of the memorandum, authored by Scott Terrill.

## Memorandum Uses CEQA Language Misleadingly

The memorandum's introductory paragraph states, "Per your request, H. T. Harvey & Associates is providing an assessment of the potential impact of The Bay Lights 360 Project on birds and fish." Normally, an assessment like this is prepared for a defined regulatory purpose—for CEQA review or in support of a permitting process. See, for example, the attached memorandum from HT Harvey, dated October 18, 2022, with subject: "777 Airport Boulevard – Updated Avian Collision Risk Assessment (HTH #4583-01)." The introduction to this 2022 memorandum states:

> Per your request, H. T. Harvey & Associates has assessed avian collision risk and lighting impacts on birds in support of the proposed 777 Airport Boulevard Project located southeast of San Francisco International Airport and north of the Burlingame Lagoon in the Bayfront neighborhood of Burlingame, California. It is our understanding that the project will demolish the existing improvements on the site and construct a 13-story, 194-foot tall building with 403,425 square feet of office space and six levels of parking. We further understand that you are requesting our assistance to assess the potential for avian collisions to occur with the proposed building for purposes of California Environmental Quality Act (CEQA) review of the project. This report summarizes our analysis of bird collision and lighting hazards associated with the project and describes measures necessary, in our opinion, to mitigate potentially significant impacts to less-than-significant levels under CEQA.

The 2022 memorandum clearly states that impacts were assessed under CEQA, and it included measures that the biologists considered "necessary . . . to mitigate potentially significant impacts to less-than-significant levels under CEQA." These are important distinctions from the 2023 memorandum for The Bay Lights 360 project.

The word "significant" has a specific meaning under section 15605(a) of CEQA:

> (a) A lead agency shall find that a project may have a significant effect on the environment and thereby require an EIR to be prepared for the project where there is substantial evidence, in light of the whole record, that any of the following conditions may occur:
>
> (1) The project has the potential to substantially degrade the quality of the environment; substantially reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; substantially reduce the number or restrict the range of an endangered, rare or threatened species; or eliminate important examples of the major periods of California history or prehistory.
>
> (2) The project has the potential to achieve short-term environmental goals to the disadvantage of long-term environmental goals.
>
> (3) The project has possible environmental effects that are individually limited but cumulatively considerable. "Cumulatively considerable" means that the incremental effects

> of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.
>
> (4) The environmental effects of a project will cause substantial adverse effects on human beings, either directly or indirectly.

The use of the word "significant" in a biological evaluation carries an implication that the assessment is being conducted in compliance with CEQA, and that the standards identified above apply to the analysis. The 2023 HT Harvey memorandum, evaluating The Bay Lights 360 project, uses the word "significant" three times and "significantly" once:

- **Page 5:** "Once installed, the LED nodes for The Bay Lights 360 Project are not likely to represent a significant change from the existing conditions, even though there will be more nodes and fixtures on the bridge."
- **Page 8:** "If the lights are installed during the breeding season, it should not significantly increase human activity levels relative to existing conditions with respect to local birds, which are habituated to the traffic and other anthropogenic activities associated with the bridge."
- **Page 8:** "The lighting should not have a significant impact on birds."
- **Page 9:** "Under current conditions, given the amount of artificial light associated with development in the San Francisco Bay Area (including the current lighting on the Bay Bridge itself), the installation of new LED lights would not significantly add to the overall lighting in the region."

The use of the term "significant" in HT Harvey's "assessment of the potential impact of The Bay Lights 360 Project on birds and fish" creates a misleading impression that a CEQA analysis, or the functional equivalent of a CEQA analysis, was completed, but this is not the case. The authors of the memorandum are undoubtedly experienced in recommending findings of significance under CEQA, and they might even argue that their evaluation represents the functional equivalent of a CEQA review, but the public plays an integral role in the CEQA review process that did not take place for this project. Under CEQA, the recommended findings of HT Harvey would have had to be formally certified and adopted by a public lead agency after completing a defined environmental review process involving (a) the solicitation of comments from the public and other responsible agencies; (b) responses to those comments from the CEQA lead agency and their consultants; and (c) any necessary adjustments to the draft findings of significance needed to adequately address the issues raised by the public and other agencies (e.g., provision of additional mitigation measures not initially considered necessary by the lead agency). Since that did not happen in this case, the findings in the HT Harvey memorandum cannot be considered the functional equivalent of CEQA findings.

## "Existing Conditions" Improperly Defined

In the first usage of "significant" quoted on the previous page, the author expressed an opinion that adding 48,000 high-intensity LED notes for The Bay Lights 360 project would not represent a "significant" change from "the existing conditions." This raises the question of what constitutes the "existing conditions." The 25,000 LEDs that were originally added to the Bay Bridge **temporarily**, under a CEQA exemption that should not have been granted (see pages 4–5 of this letter), were removed in 2015, ending that project. A second installation of different LEDs took place from 2016 to 2023. At the time of the HT Harvey memorandum, **no decorative LED lights were on the Bay Bridge** (see Figure 3 on page 3 of this letter). The only reason for expecting the future installation of 48,000 lights on the bridge was because The Bay Lights 360 project had been granted both a CEQA exemption and a "non-material amendment" to permit M2012.009, neither of which should have been deemed applicable to The Bay Lights 360 project. For these reasons, any evaluation of The Bay Lights 360 project should take the unlit West Span of the Bay Bridge as the "existing conditions."

## HT Harvey's 2022 Memorandum

The 2022 memorandum for 777 Airport Boulevard, referred to previously in this letter, evaluated a proposed 13-story building in Burlingame, near San Francisco Airport and along the southwestern shore of San Francisco Bay. Although the design of that project incorporated numerous measures designed to minimize spillage of light, HT Harvey's discussion of potential adverse effects of lighting on birds described a wide variety of potential adverse effects of the project and emphasized the need to reduce light spillage toward San Francisco Bay to the maximum extent feasible. For example, pages 14–15 of the 2022 memorandum state:

> Evidence that migrating birds are attracted to artificial light sources is abundant in the literature as early as the late 1800s (Gauthreaux and Belser 2006). Although the mechanism causing migrating birds to be attracted to bright lights is unknown, the attraction is well documented (Longcore and Rich 2004, Gauthreaux and Belser 2006). Migrating birds are frequently drawn from their migratory flight paths into the vicinity of an artificial light source, where they will reduce their flight speeds, increase vocalizations, and/or end up circling the lit area, effectively "captured" by the light (Herbert 1970, Gauthreaux and Belser 2006, Sheppard and Phillips 2015, Van Doren et al. 2017). When birds are drawn to artificial lights during their migration, they may become disoriented and possibly blinded by the intensity of the light (Gauthreaux and Belser 2006). The disorienting and blinding effects of artificial lights directly impact migratory birds by causing collisions with light structures, buildings, communication and power structures, or even the ground (Gauthreaux and Belser 2006). Indirect impacts on migrating birds might include orientation mistakes and increased length of migration due to light-driven detours.

The Bay Lights 360, like the projects before it, involves up-lighting, in that the 48,000 LEDs are not shielded but rather disperse light in all directions from each LED. Pages 15 and 16 of HT Harvey's 2022 memorandum provide detailed discussions of the potential adverse effects of up-lighting, specifically describing problems that may be especially problematic in and around the San Francisco Bay. Although LEDs placed on the Bay Bridge do not specifically direct their light upward, nor are they shielded to project light only downward; rather, they emit light in all directions, and the tens of thousands of LEDs are specifically intended to be visible from long distances around San Francisco Bay. As such, the hazards of uplighting described in HT Harvey's 2022 memorandum are relevant to any objective evaluation of The Bay Lights 360.

**Impacts Related to Up-Lighting**

Up-lighting refers to light that projects upwards above the fixture. There are two primary ways in which the luminance of up-lights might impact the movements of birds. First, local birds using habitats on a site may become disoriented during flights among foraging areas and fly toward the lights, colliding with the lights or with nearby structures. Second, nocturnally migrating birds may alter their flight direction or behavior upon seeing lights; the birds may be drawn toward the lights or may become disoriented, potentially striking objects such as buildings, adjacent power lines, or even the lights themselves. These two effects are discussed separately below.

**Local Birds.** Seabirds may be especially vulnerable to artificial lights because many species are nocturnal foragers that have evolved to search out bioluminescent prey (Imber 1975, Reed et al. 1985, Montevecchi 2006), and thus are strongly attracted to bright light sources. When seabirds approach an artificial light, they seem unwilling to leave it and may become "trapped" within the sphere of the light source for hours or even days, often flying themselves to exhaustion or death (Montevecchi 2006). Seabirds using habitats associated with the San Francisco Bay to the north include primarily gulls and terns. Although none of these species are primarily nocturnal foragers, there is some possibility that gulls, which often fly at night, may fly in areas where they could be disoriented by up-lights under conditions dark enough that the lights would affect the birds. Shorebirds forage along the San Francisco Bay nocturnally as well as diurnally, and move frequently between foraging locations in response to tide levels and prey availability. Biologists and hunters have long used sudden bright light as a means of blinding and trapping shorebirds (Gerstenberg and Harris 1976, Potts and Sordahl 1979), so evidence that shorebirds are affected by bright light is well established. Though impacts of a consistent bright light are undocumented, it is possible that shorebirds, like other bird species, may be disoriented by a very bright light in their flight path.

Passerine species have been documented responding to increased illumination in their habitats with nocturnal foraging and territorial defense behaviors (Longcore and Rich 2004, Miller 2006, de Molenaar et al. 2006), but absent significant illumination, they typically do not forage at night, leaving them less susceptible to the attraction and disorientation caused by luminance when they are not migrating.

**Migrating Birds.** Numerous bird species migrate nocturnally in order to avoid diurnal predators and minimize energy expenditures. Bird migration over land typically occurs at altitudes of up to 5,000 feet, but is highly variable by species, region, and weather conditions (Kerlinger 1995, Newton 2008). In general, night-migrating birds optimize their altitude based on local conditions, and most songbird and soaring bird migration over land occurs at altitudes below 2,000 feet, while waterfowl and shorebirds typically migrate at higher altitudes (Kerlinger 1995, Newton 2008).

It is unknown what light levels adversely affect migrating birds, and at what distances birds respond to lights (Sheppard and Phillips 2015). In general, vertical beams are known to capture higher numbers of birds flying at lower altitudes. High-powered 7,000-watt (equivalent to 105,000-lumen) spotlights that reach altitudes of up to 4 miles (21,120 feet) in the sky have been shown to capture birds migrating at varying altitudes, with most effects occurring below 2,600 feet (where most migration occurs); however, effects were also documented at the upper limits of bird migration at approximately 13,200 feet (Van Doren *et al.* 2017). A study of bird responses to up-lighting from 250-watt (equivalent to 3,750-lumen) spotlights placed on the roof of a 533-foot tall building and directed upwards at a company logo documented behavioral changes in more than 90% of the birds that were visually observed flying over the building at night (Haupt and Schillemeit 2011). One study of vertical lights projecting up to 3,280 feet found that higher numbers of birds were captured at altitudes below 650 feet, but this effect was influenced by wind direction and the birds' flight speed (Bolshakov et al. 2013). These studies have not analyzed the capacity for vertical lights to attract migrating birds flying beyond their altitudinal range, and the potential for any project up-lights to affect birds flying at various altitudes is unknown. Thus, birds that encounter beams from up-lights are likely to respond to the lights, and may become disoriented or attracted to the lights to the point that they collide with buildings or other nearby structures, but the range of the effect of the lights is unknown.

Observations of bird behavioral responses to up-lights indicate that their behaviors return to normal quickly once up-lights are completely switched off (Van Doren et al. 2017), but no studies are available that demonstrate bird behavioral responses to reduced or dimmed up-lights. In general, up-lights within very dark areas are more likely to "capture" and disorient migrating birds, whereas up-lights in brightly lit areas (e.g., highly urban areas, such as Burlingame) are less likely to capture birds (Sheppard 2017). Birds are also known to be more susceptible to capture by artificial light when they are descending from night migration flights in the early mornings compared to when they ascend in the evenings; as a result, switching off up-lights after midnight can minimize adverse effects on migrating birds (Sheppard 2017). However, more powerful up-lights (e.g., 3,000 lumen spotlights) may create issues for migrating birds regardless of the time of night they are used (Sheppard 2017).

HT Harvey's evaluation of potential lighting effects of the proposed 13-story building in Burlingame is provided on pages 16–17 of the 2022 memorandum:

### Analysis of Potential Project Impacts on Birds due to Lighting

No detailed information regarding the project's proposed lighting design was available for review as part of this assessment. Nevertheless, construction of the project will create new sources of lighting on the site. Lighting would be the result of light fixtures illuminating buildings, building architectural lighting, pedestrian lighting, and artistic lighting. Depending on the location, direction, and intensity, this lighting can potentially spill into adjacent natural areas, thereby resulting in an increase in lighting compared to existing conditions. Areas immediately to the north, west, and east of the project site are primarily developed urban habitats that do not support bird communities that might be substantially affected by illuminance from the project. However, birds inhabiting more natural habitat areas along Burlingame Lagoon to the south may be affected by an increase in lighting.

Lighting from the project also has some potential to attract and/or disorient birds, especially during inclement weather when nocturnally migrating birds descend to lower altitudes. As a result, some birds moving along the

> San Francisco Bay at night may be (1) attracted to the site, where they are more likely to collide with buildings; and/or (2) disoriented by night lighting, potentially causing them to collide with the buildings. Certain migrant birds that use structures for roosting and foraging (such as swifts and swallows) would be vulnerable to collisions if they perceive illuminated building interiors as potential roosting habitat and attempt to enter the buildings through glass walls. Similarly, migrant and resident birds would be vulnerable to collisions if they perceive illuminated vegetation within buildings as potential habitat and attempt to enter a building through glass walls.
>
> Thus, because the project site is located in the immediate vicinity of natural areas along the San Francisco Bay, especially Burlingame Lagoon immediately south of the site, lighting associated with the project has a greater potential to (1) spill southwards into sensitive habitats along Burlingame Lagoon, and (2) attract and/or disorient migrating birds during the spring and fall, compared to buildings located farther inland in Burlingame.
>
> The project will implement a general strategy to minimize lighting, as well as specific measures to ensure that the spill of lighting upwards and outwards into adjacent natural areas will be minimized to an appropriate level. With the implementation of these measures, which are listed under *Project Measures to Minimize Lighting* above, project impacts on birds due to lighting are less than significant under CEQA, in our professional opinion.

Naturally, some of the potential project light impacts on birds associated with constructing a 13-story building in Burlingame will not be applicable to installing 48,000 LEDs on the Bay Bridge, but some of them are. In particular, lighting the bridge has the potential to attract and/or disorient birds, especially during inclement weather, and these birds could collide with support cables or other parts of the bridge structure. Such effects would be greater during the spring and fall migration periods.

## HT Harvey's 2023 Memorandum

The 2023 memorandum, evaluating The Bay Lights 360, downplays the potential for adverse effects on migratory birds and describes selected studies putatively favorable to project proponents. Page 8 states:

> The lighting should not have a significant impact on birds. Nocturnal migrants collide primarily with towers and other structures that are lit with constant white light (Gauthreaux and Belser 2006). These birds also collide with buildings that have lit windows at night during migration. This phenomenon is most pronounced in eastern and central North America (likely due to increased numbers of migrant birds relative to western North America; Horton et al. 2019) and, with respect to towers, collision typically occurs when guy wires secure the towers. Strobe lights and colored lights (especially green) substantially reduce the collision rates of migrants with lit structures (Gauthreaux and Belser 2006). A field study in the in the North Sea found that nocturnally migrating birds were disoriented and attracted by red and white light, whereas they were "clearly less disoriented by blue and green light" (Poot et al. 2008). Multiple studies have found that flashing or blinking lights are less attractive to migrating birds relative to continuous light (Gauthreaux and Belser 2006; Gehring et al. 2009) and several have found that numbers of birds around blinking modes (intermittent, continuous) did not differ from numbers of birds under darkness conditions (Rebke et al. 2019). In the case of The Bay Lights 360 Project, the lights on display are not single-source, nor static. The movement patterns associated with the lighting scheme should not attract or disorient (leading to collision of) migrants. The addition of constant white lighting sources

> to the existing light installation on the bridge during nighttime construction could slightly increase the likelihood of collision for nocturnally migrating birds, especially during foggy or stormy nights. However, the bridge is already well lit at night for safety reasons.

Although nocturnal migrants may collide primarily with towers and other structures that are lit with constant white light, no study has evaluated how nocturnal migrants react to tens of thousands of high-intensity LEDs strung on dozens of strands along 1.8 miles of a bridge in San Francisco Bay. An ambitious and innovative 2023 study by Kyle G. Horton and colleagues[5], the Abstract of which is provided below, suggests that the effects of creating such a large area of skyglow are likely to be significantly adverse:

> As billions of nocturnal avian migrants traverse North America, twice a year they must contend with landscape changes driven by natural and anthropogenic forces, including the rapid growth of the artificial glow of the night sky. While airspaces facilitate migrant passage, terrestrial landscapes serve as essential areas to restore energy reserves and often act as refugia—making it critical to holistically identify stopover locations and understand drivers of use. Here, we leverage over 10 million remote sensing observations to develop seasonal contiguous United States layers of bird migrant stopover density. In over 70% of our models, we identify skyglow as a highly influential and consistently positive predictor of bird migration stopover density across the United States. This finding points to the potential of an expanding threat to avian migrants: peri-urban illuminated areas may act as ecological traps at macroscales that increase the mortality of birds during migration.

The results of this study indicate that, even if individual LEDs of The Bay Lights 360 may be lit only intermittently, the overall effect of the project is to create a 1.8-mile-long area of skyglow that can serve as an "ecological trap" for nocturnally migrating birds.

Rebke et al. (2019)[6], cited repeatedly in support of HT Harvey's conclusions, deployed "two colour change spotlights . . . installed less than 1 m apart" to evaluate differences in avian responses to constant and blinking lights of different colors. Their Abstract concludes by stating:

> Our results suggest that light sources offshore should be restricted to a minimum, but if lighting is needed, blinking light is to be preferred over continuous light, and if continuous light is required, red light should be applied.

The proposed actions do not restrict light sources offshore "to a minimum," but rather add light sources gratuitously. Also, comparing the overall effect of 48,000 LEDs blinking at different rates to the effect of two spotlights, one blinking and the other constant, is a stretch.

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[5] Horton, K.G., Buler, J.J., Anderson, S.J. *et al.* 2023. Artificial light at night is a top predictor of bird migration stopover density. Nature Communications 14, 7446. https://doi.org/10.1038/s41467-023-43046-z

[6] Rebke, M., Dierschke, V., Weiner, C.N. *et al.* 2019. Attraction of nocturnally migrating birds to artificial light: The influence of colour, intensity and blinking mode under different cloud cover conditions. Biological Conservation 233:220-227. https://doi.org/10.1016/j.biocon.2019.02.029.

With regard to the selection of 4,000-kelvin LEDs for The Bay Lights 360 project, the HT Harvey memorandum states:

> As indicated above, higher CCTs generally have greater effects on wildlife (Longcore et al. 2018a). Currently, recommendations for reducing effects on biota vary from less than or equal to 3000 to 2700 (e.g., Longcore et al 2018; International Dark Sky Association: https://www.darksky.org/). In the case of potentially attracting nocturnally migrating birds, we know of no research on the effects of differential light temperature in blinking versus static LED lights. However, research indicates no difference in the attractiveness of dynamic lights that are of different colors (which translates into varying temperature) (Rebke et al. 2019).

Even being as charitable as possible toward the proposed action, the memorandum acknowledges that the use of 4,000-kelvin LEDs conflicts with the cited (2018) recommendation of using lights in the "3000 to 2700" range. The current (2024) recommendation of Dr. Longcore and colleagues for reducing adverse effects to living creatures, including humans, is to "Use lights with a colour temperature less than 2700K, preferably less than 2200K. This aids night vision by all animals, including people." [7]

## "Overall Summary" of the 2023 Memorandum Leaves Questions

The following "Overall Summary" is provided on page 9 of HT Harvey's 2023 memorandum.

> The Bay Bridge and vicinity in San Francisco Bay is currently extremely well-lit with artificial light at night. Based on our analysis of the proposed Project and updated scientific information since the original project memo, the additional lighting from the Bay Bridge 360 Project is not anticipated to have additional effects on listed fish or avian species, except for the potential to affect avian species directly during installation if nests are impacted during breeding season.

The "original project memo" mentioned in this paragraph is not identified in the References section, and I could not find it online, so I was not able to review the original project memo.

Pointing out that the Bay Bridge and other structures in and around the San Francisco Bay are "currently extremely well-lit with artificial light at night" only highlights the problem of ever-increasing additions of artificial light to the San Francisco Bay. The continual, largely unmitigated addition of purely decorative LED lighting to numerous bridges and other structures in and around the Bay, despite a growing mountain of scientific evidence pointing to adverse effects of doing so upon wildlife and people, is the epitome of a cumulatively considerable impact that demands CEQA review. That these projects are adding these lights under claims of categorical exemption from CEQA is a betrayal of the public trust placed in the agencies making these determinations.

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[7] Welch, D., Dick, R., Treviño, K., Longcore, T., *et al*. 2024. The world at night: Preserving natural darkness for heritage conservation and night sky appreciation. IUCN WCPA Good Practice Guidelines Series No. 33, Gland, Switzerland: IUCN. https://portals.iucn.org/library/sites/library/files/documents/PAG-033-En.pdf

Finally, note that the HT Harvey memorandum concludes that the Bay Bridge 360 Project "is not anticipated to have additional effects on **listed** fish or avian species" [emphasis added in bold]. This focus solely on listed species suggests that the HT Harvey memorandum is considering the proposed actions in the context of NEPA, a federal law that often focuses on "the degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973" (NEPA Section 1508.27(9)). Projects in California that undergo NEPA review typically must also complete CEQA review, a State process that considers the potential effects of the proposed action on non-listed species (e.g., California Species of Special Concern).

## SUMMARY AND CONCLUSION

Based on my review of the permitting history for The Bay Lights 360 project and the HT Harvey memorandum prepared in support of the project, and given my understanding of the best available scientific literature regarding the adverse effects of artificial lighting on various forms of wildlife, I conclude that your ongoing legal action to require The Bay Lights 360 project to undergo CEQA review is fully warranted. Furthermore, Dr. Travis Longcore reviewed the final draft of this letter and explicitly endorses the conclusions drawn herein.

Thank you for the opportunity to work with you on this important undertaking. Please call me at 562-477-2181 if you have questions or wish to further discuss any matters; you may send e-mail to robb@hamiltonbiological.com.

Sincerely,

Robert A. Hamilton
President, Hamilton Biological, Inc.

Attached: curriculum vitae
NOE dated 8/15/23 issued by BATA for The Bay Lights 360 project
Report: Assessing the Impacts of LED Lighting to Wildlife
CDFW letter dated 7/13/2021 re: the *Plan Bay Area 2050* DEIR
HT Harvey memo dated 10/8/22
HT Harvey memo dated 3/23/24

# Robert A. Hamilton

*President, Hamilton Biological, Inc.*

## Expertise

Endangered Species Surveys
General Biological Surveys
CEQA Analysis
Population Monitoring
Vegetation Mapping
Construction Monitoring
Noise Monitoring
Open Space Planning
Natural Lands Management

## Education

1988. Bachelor of Science degree in Biological Sciences, University of California, Irvine

## Professional Experience

1994 to Present. Independent Biological Consultant, Hamilton Biological, Inc.

1988 to 1994. Biologist, LSA Associates, Inc.

## Permits

Federal Permit to survey for the Coastal California Gnatcatcher and Southwestern Willow Flycatcher

MOUs with the California Dept. of Fish and Game to survey for Coastal California Gnatcatcher, Southwestern Willow Flycatcher, and Coastal Cactus Wren.

California Scientific Collecting Permit

Robert A. Hamilton has been providing biological consulting services in southern California since 1988. He spent the formative years of his career at the firm of LSA Associates in Irvine, where he was a staff biologist and project manager. He has worked as an independent and on-call consultant since 1994, incorporating his business as Hamilton Biological, Inc., in 2009. The consultancy specializes in the practical application of environmental policies and regulations to land management and land use decisions in southern California.

A recognized authority on the status, distribution, and identification of birds in California, Mr. Hamilton is the lead author of two standard references describing aspects of the state's avifauna: *The Birds of Orange County: Status & Distribution* and *Rare Birds of California.* Mr. Hamilton has also conducted extensive studies in Baja California, and for seven years edited the Baja California Peninsula regional reports for the journal *North American Birds*. He served ten years on the editorial board of *Western Birds* and regularly publishes in peer-reviewed journals. He is a founding member of the Coastal Cactus Wren Working Group and in 2011 updated the Cactus Wren species account for *The Birds of North America Online*. Mr. Hamilton's expertise includes vegetation mapping. From 2007 to 2010 he worked as an on-call biological analyst for the County of Los Angeles Department of Regional Planning. From 2010 to 2021, he conducted construction monitoring and focused surveys for special-status bird species on the Tehachapi Renewable Transmission Project (TRTP). He is a former member of the Los Angeles County Significant Ecological Areas Technical Advisory Committee (SEATAC).

Mr. Hamilton conducts general and focused biological surveys of small and large properties as necessary to obtain various local, state, and federal permits, agreements, and clearances. He also conducts landscape-level surveys needed by land managers to monitor songbird populations. Mr. Hamilton holds the federal and state permits and MOUs listed to the left, and he is recognized by federal and state resource agencies as being highly qualified to survey for the Least Bell's Vireo. He also provides nest-monitoring services in compliance with the federal Migratory Bird Treaty Act and California Fish & Game Code Sections 3503, 3503.5 and 3513.

### Board Memberships, Advisory Positions, Etc.

Friends of Colorado Lagoon, Board Member (2014–present)

Coastal Cactus Wren Working Group (2008–present)

Los Angeles County Significant Ecological Areas Technical Advisory Committee (SEATAC) (2010–2014)

American Birding Association: Baja Calif. Peninsula Regional Editor, North American Birds (2000–2006)

Western Field Ornithologists: Associate Editor of Western Birds (1999–2008)

California Bird Records Committee (1998–2001)

Nature Reserve of Orange County: Technical Advisory Committee (1996–2001)

California Native Plant Society, Orange County Chapter: Conservation Chair (1992–2003)

### Professional Affiliations

American Ornithologists' Union

American Ornithological Society (Fellow)

Cooper Ornithological Society

Institute for Bird Populations

California Native Plant Society

Southern California Academy of Sciences

Western Foundation of Vertebrate Zoology

Mr. Hamilton is an expert photographer, and typically provides photo-documentation and/or video documentation as part of his services.

Drawing upon a robust, multi-disciplinary understanding of the natural history and ecology of his home region, Mr. Hamilton works with private and public land owners, as well as governmental agencies and interested third parties, to apply the local, state, and federal land use policies and regulations applicable to each unique situation. Mr. Hamilton has amassed extensive experience in the preparation and independent review of CEQA documents, from relatively simple Negative Declarations to complex supplemental and recirculated Environmental Impact Reports. In addition to his knowledge of CEQA and its Guidelines, Mr. Hamilton understands how each Lead Agency brings its own interpretive variations to the CEQA review process.

## Representative Project Experience

From 2018 to 2020, Mr. Hamilton worked on behalf of Endangered Habitats League to review and eventually challenge and overturn the findings of an EIR for the proposed Village 14 project on 1,200+ acres in the middle of Proctor Valley. This important area is located in southwestern San Diego County, near the Rancho Jamul Ecological Reserve and San Diego National Wildlife Refuge. Among many listed and special-status plant and wildlife species, Proctor Valley is home to the endangered Quino Checkerspot Butterfly. Ultimately, Mr. Hamilton was able to demonstrate that the EIR did not accurately describe the biological resources present on the project site or on a nearby parcel that the project proponent had offered to the State of California in a land-exchange. Mr. Hamilton reviewed, analyzed, and rebutted numerous biological reports and memoranda prepared by the project proponent's consultants. When the County of San Diego certified EIR anyway, Mr. Hamilton worked with Endangered Habitats League to educate members of the State Wildlife Conservation Board, whose approval was required for the land-exchange deal. In December 2020 the Board unanimously rejected the deal, citing the inaccurate reporting of resources that Mr. Hamilton brought to light, and in January 2024 the State purchased the land for conservation purposes.

### Insurance

$3,000,000 professional liability policy (Hanover Insurance Group)

$2,000,000 general liability policy (The Hartford)

$1,000,000 auto liability policy (State Farm)

### Other Relevant Experience

Field Ornithologist, San Diego Natural History Museum Scientific Collecting Expedition to Central and Southern Baja California, October/November 1997 and November 2003.

Field Ornithologist, Island Conservation and Ecology Group Expedition to the Tres Marías Islands, Nayarit, Mexico, 23 January to 8 February 2002.

Field Ornithologist, Algalita Marine Research Foundation neustonic plastic research voyages in the Pacific Ocean, 15 August to 4 September 1999 and 14 to 28 July 2000.

Field Assistant, Bird Banding Study, Río Ñambí Reserve, Colombia, January to March 1997.

### References

Provided upon request.

From 2008 to 2023, Mr. Hamilton served as the main biological consultant for the Banning Ranch Conservancy, a local citizens' group that successfully defeated efforts to implement a large proposed residential and commercial project on the 400-acre Banning Ranch property in Newport Beach. Mr. Hamilton reviewed, analyzed, and responded to numerous biological reports prepared by the project proponent, and testified at multiple public hearings of the California Coastal Commission. In September 2016, the Commission denied the application for a Coastal Development Permit for the project, citing, in part, Mr. Hamilton's analysis of biological issues. In March 2017, the California Supreme Court issued a unanimous opinion (*Banning Ranch Conservancy v. City of Newport Beach*) holding that the EIR prepared by the City of Newport Beach improperly failed to identify areas of the site that might qualify as "environmentally sensitive habitat areas" under the California Coastal Act. In nullifying the certification of the EIR, the Court found that the City "ignored its obligation to integrate CEQA review with the requirements of the Coastal Act."

From 2012 to 2014, Mr. Hamilton collaborated with Dan Cooper on *A Conservation Analysis for the Santa Monica Mountains "Coastal Zone" in Los Angeles County*, and worked with Mr. Cooper and the County of Los Angeles to secure a certified Local Coastal Program (LCP) for 52,000 acres of unincorporated County lands in the Santa Monica Mountains coastal zone. The work involved synthesizing large volumes of existing baseline information on the biological resources of the study area, evaluating existing land use policies, and developing new policies and guidelines for future development within this large, ecologically sensitive area. A coalition of environmental organizations headed by the Surfrider Foundation selected this project as the "Best 2014 California Coastal Commission Vote."

## Contact Information

Robert A. Hamilton, President
Hamilton Biological, Inc.

316 Monrovia Avenue
Long Beach, CA 90803

562-477-2181 (office, mobile)

robb@hamiltonbiological.com
http://hamiltonbiological.com

## Third Party Review of CEQA Documents

Under contract to cities, conservation groups, homeowners' associations, etc., Mr. Hamilton has reviewed EIRs and other project documentation for the following projects:

- Piraeus Point (residential, City of Encinitas)
- Cottonwood Sand Mine (golf course to aggregate mine, County of San Diego)
- Alpine County Regional Park (park establishment, County of San Diego)
- Trails at Carmel Mtn. Ranch (golf course to residential, City of San Diego)
- Otay Village 13 (residential, County of San Diego)
- Otay Village 14, Planning Areas 16/19 (residential, County of San Diego)
- Western Snowy Plover Mgmt. Plan (resource management, City of Newport Beach)
- Sanderling Waldorf School (commercial, City of Encinitas)
- Diamond Bar General Plan (open space planning, City of Diamond Bar)
- UC San Diego Long-range Development Plan (institutional, UC Regents)
- El Monte Sand Mining Project (resource extraction, County of San Diego)
- Faria/Southwest Hills Annexation Project (residential, City of Pittsburg)
- Los Cerritos Oil Consolidation/Wetland Restoration Project (resource extraction/habitat restoration, City of Long Beach)
- Safari Highlands Ranch (residential, City of Escondido)
- Newland Sierra (residential, County of San Diego)
- Harmony Grove Village South (residential, County of San Diego)
- Vegetation Treatment Program (statewide fire management plan, California Department of Forestry and Fire Protection)
- Watermark Del Mar Specific Plan (residential, City of Del Mar)
- Newport Banning Ranch (residential/commercial, City of Newport Beach)
- Davidon/Scott Ranch (residential, City of Petaluma)
- Mission Trails Regional Park Master Plan (open space planning, City of San Diego)
- Esperanza Hills (residential, County of Orange)
- Warner Ranch (residential, County of San Diego)
- Dog Beach, Santa Ana River Mouth (open space planning, County of Orange)
- Gordon Mull subdivision (residential, City of Glendora)
- The Ranch at Laguna Beach (resort, City of Laguna Beach)
- Sunset Ridge Park (city park, City of Newport Beach)
- The Ranch Plan (residential/commercial, County of Orange)
- Southern Orange County Transportation Infrastructure Improvement Project (Foothill South Toll Road, County of Orange)
- Gregory Canyon Landfill Rest. Plan (proposed mitigation, County of San Diego)
- Montebello Hills Specific Plan EIR (residential, City of Montebello; 2009 and 2014 circulations)
- Cabrillo Mobile Home Park (illegal wetland filling, City of Huntington Beach)
- Newport Hyatt Regency (timeshare conversion project, City of Newport Beach)
- Lower San Diego Creek "Emergency Repair Project" (flood control, County of Orange)
- Tonner Hills (residential, City of Brea)
- The Bridges at Santa Fe Units 6 and 7 (residential, County of San Diego)
- Villages of La Costa Master Plan (residential/commercial, City of Carlsbad)
- Whispering Hills (residential, City of San Juan Capistrano)
- Santiago Hills II (residential/commercial, City of Orange)
- Rancho Potrero Leadership Academy (youth detention facility, County of Orange)
- Saddle Creek/Saddle Crest (residential, County of Orange)
- Frank G. Bonelli Regional County Park Master Plan (County of Los Angeles)

## Selected Presentations

Hamilton, R. A. Six Legs Good/Invertebral Limit. 2012-2020. 60-to-90-minute multimedia presentation on the identification and photography of dragonflies, damselflies, butterflies, and other invertebrates, given at Audubon Society chapter meetings, Irvine Ranch Conservancy, etc.

Hamilton, R. A. Birds of Colorado Lagoon. 2018-2019. 60-minute multimedia presentation on the history and avifauna of Colorado Lagoon in southeastern Long Beach, given at Audubon Society chapter meetings.

Hamilton, R. A., and Cooper, D. S. 2016. Nesting Bird Policies: We Can Do Better. Twenty-minute multimedia presentation at The Wildlife Society Western Section Annual Meeting, February 23, 2016.

Hamilton, R. A. 2012. Identification of Focal Wildlife Species for Restoration, Coyote Creek Watershed Master Plan. Twenty-minute multimedia presentation given at the Southern California Academy of Sciences annual meeting at Occidental College, Eagle Rock, 4 May. Abstract published in the Bulletin of the Southern California Academy of Sciences No. 111(1):39.

Hamilton, R. A., and Cooper, D. S. 2009-2010. Conservation & Management Plan for Marina del Rey. Twenty-minute multimedia presentation given to different governmental agencies and interest groups.

Hamilton, R. A. 2008. Cactus Wren Conservation Issues, Nature Reserve of Orange County. One-hour multimedia presentation for Sea & Sage Audubon Society, Irvine, California, 25 November.

Hamilton, R. A., Miller, W. B., Mitrovich, M. J. 2008. Cactus Wren Study, Nature Reserve of Orange County. Twenty-minute multimedia presentation given at the Nature Reserve of Orange County's Cactus Wren Symposium, Irvine, California, 30 April 2008.

Hamilton, R. A. and K. Messer. 2006. 1999-2004 Results of Annual California Gnatcatcher and Cactus Wren Monitoring in the Nature Reserve of Orange County. Twenty-minute multimedia presentation given at the Partners In Flight meeting: Conservation and Management of Coastal Scrub and Chaparral Birds and Habitats, Starr Ranch Audubon Sanctuary, 21 August 2004; and at the Nature Reserve of Orange County 10th Anniversary Symposium, Irvine, California, 21 November.

## Publications

Hamilton, R. A. 2022. Book review: Bird Versus Bulldozer. *Western Birds* 53:335–339.

Hamilton, R. A. 2022. Book review: All About Birds, California. *Western Birds* 53:177–179.

Hamilton, R. A. 2022. Book review: Sacramento County Breeding Birds. *Western Birds* 53:83–85.

Gómez de Silva, H., Villafaña, M. G. P., Nieto, J. C., Cruzado, J., Cortés, J. C., Hamilton, R. A., Vásquez, S. V., and Nieto, M. A. C. 2017. Review of the avifauna of The Tres Marías Islands, Mexico, including new and noteworthy records. *Western Birds* 47:2–25.

Hamilton, R. A. 2014. Book review: The Sibley Guide to Birds, Second Edition. *Western Birds* 45:154–157.

Cooper, D. S., R. A. Hamilton, and S. D. Lucas. 2012. A population census of the Cactus Wren in coastal Los Angeles County. *Western Birds* 43:151–163.

Hamilton, R. A., J. C. Burger, and S. H. Anon. 2012. Use of artificial nesting structures by Cactus Wrens in Orange County, California. *Western Birds* 43:37–46.

Hamilton, R. A., Proudfoot, G. A., Sherry, D. A., and Johnson, S. 2011. Cactus Wren (*Campylorhyn-chus brunneicapillus*), *in* The Birds of North America Online (A. Poole, ed.). Cornell Lab of Ornithology, Ithaca, NY.

Hamilton, R. A. 2008. Cactus Wrens in central & coastal Orange County: How will a worst-case scenario play out under the NCCP? *Western Tanager* 75:2–7.

Erickson, R. A., R. A. Hamilton, R. Carmona, G. Ruiz-Campos, and Z. A. Henderson. 2008. Value of perennial archiving of data received through the North American Birds regional reporting system: Examples from the Baja California Peninsula. *North American Birds* 62:2–9.

Erickson, R. A., R. A. Hamilton, and S. G. Mlodinow. 2008. Status review of Belding's Yellowthroat *Geothlypis beldingi*, and implications for its conservation. Bird Conservation International 18:219–228.

Hamilton, R. A. 2008. Fulvous Whistling-Duck (*Dendrocygna bicolor*). Pp. 68-73 *in* California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (Shuford, W. D. and T. Gardali, eds.). Studies of Western Birds 1. Western Field Ornithologists, Camarillo, CA, and California Department of Fish and Game, Sacramento, CA.

California Bird Records Committee (R. A. Hamilton, M. A. Patten, and R. A. Erickson, editors.). 2007. Rare Birds of California. Western Field Ornithologists, Camarillo, CA.

Hamilton, R. A., R. A. Erickson, E. Palacios, and R. Carmona. 2001–2007. *North American Birds* quarterly reports for the Baja California Peninsula Region, Fall 2000 through Winter 2006/2007.

Hamilton, R. A. and P. A. Gaede. 2005. Pink-sided × Gray-headed Juncos. *Western Birds* 36:150–152.

Mlodinow, S. G. and R. A. Hamilton. 2005. Vagrancy of Painted Bunting (*Passerina ciris*) in the United States, Canada, and Bermuda. *North American Birds* 59:172–183.

Erickson, R. A., R. A. Hamilton, S. González-Guzmán, G. Ruiz-Campos. 2002. Primeros registros de anidación del Pato Friso (*Anas strepera*) en México. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 73(1):67–71.

Hamilton, R. A. and J. L. Dunn. 2002. Red-naped and Red-breasted sapsuckers. *Western Birds* 33:128–130.

Hamilton, R. A. and S. N. G. Howell. 2002. Gnatcatcher sympatry near San Felipe, Baja California, with notes on other species. *Western Birds* 33:123–124.

Hamilton, R. A. 2001. Book review: The Sibley Guide to Birds. *Western Birds* 32:95–96.

Hamilton, R. A. and R. A. Erickson. 2001. Noteworthy breeding bird records from the Vizcaíno Desert, Baja California Peninsula. Pp. 102-105 *in* Monographs in Field Ornithology No. 3. American Birding Association, Colorado Springs, CO.

Hamilton, R. A. 2001. Log of bird record documentation from the Baja California Peninsula archived at the San Diego Natural History Museum. Pp. 242–253 *in* Monographs in Field Ornithology No. 3. American Birding Association, Colorado Springs, CO.

Hamilton, R. A. 2001. Records of caged birds in Baja California. Pp. 254–257 *in* Monographs in Field Ornithology No. 3. American Birding Association, Colorado Springs, CO.

Erickson, R. A., R. A. Hamilton, and S. N. G. Howell. 2001. New information on migrant birds in northern and central portions of the Baja California Peninsula, including species new to Mexico. Pp. 112–170 *in* Monographs in Field Ornithology No. 3. American Birding Association, Colorado Springs, CO.

Howell, S. N. G., R. A. Erickson, R. A. Hamilton, and M. A. Patten. 2001. An annotated checklist of the birds of Baja California and Baja California Sur. Pp. 171–203 *in* Monographs in Field Ornithology No. 3. American Birding Association, Colorado Springs, CO.

Ruiz-Campos, G., González-Guzmán, S., Erickson, R. A., and Hamilton, R. A. 2001. Notable bird specimen records from the Baja California Peninsula. Pp. 238–241 *in* Monographs in Field Ornithology No. 3. American Birding Association, Colorado Springs, CO.

Wurster, T. E., R. A. Erickson, R. A. Hamilton, and S. N. G. Howell. 2001. Database of selected observations: an augment to new information on migrant birds in northern and central portions of the Baja California Peninsula. Pp. 204–237 *in* Monographs in Field Ornithology No. 3. American Birding Association, Colorado Springs, CO.

Erickson, R. A. and R. A. Hamilton, 2001. Report of the California Bird Records Committee: 1998 records. *Western Birds* 32:13–49.

Hamilton, R. A., J. E. Pike, T. E. Wurster, and K. Radamaker. 2000. First record of an Olive-backed Pipit in Mexico. *Western Birds* 31:117–119.

Hamilton, R. A. and N. J. Schmitt. 2000. Identification of Taiga and Black Merlins. *Western Birds* 31:65–67.

Hamilton, R. A. 1998. Book review: Atlas of Breeding Birds, Orange County, California. *Western Birds* 29:129–130.

Hamilton, R. A. and D. R. Willick. 1996. The Birds of Orange County, California: Status and Distribution. Sea & Sage Press, Sea & Sage Audubon Society, Irvine.

Hamilton, R. A. 1996–98. Photo Quizzes. *Birding* 27(4):298-301, 28(1):46-50, 28(4):309-313, 29(1): 59-64, 30(1):55–59.

Erickson, R. A., and Hamilton, R. A. 1995. Geographic distribution: *Lampropeltis getula californiae* (California Kingsnake) in Baja California Sur. *Herpetological Review* 26(4):210.

Bontrager, D. R., R. A. Erickson, and R. A. Hamilton. 1995. Impacts of the October 1993 Laguna fire on California Gnatcatchers and Cactus Wrens. *in* J. E. Keeley and T. A. Scott (editors). Wildfires in California Brushlands: Ecology and Resource Management. International Association of Wildland Fire, Fairfield, Washington.

Erickson, R. A., R. A. Hamilton, S. N. G. Howell, M. A. Patten, and P. Pyle. 1995. First record of Marbled Murrelet and third record of Ancient Murrelet for Mexico. *Western Birds* 26: 39–45.

Erickson, R. A., and R. A. Hamilton. 1993. Additional summer bird records for southern Mexico. *Euphonia* 2(4): 81–91.

Erickson, R. A., A. D. Barron, and R. A. Hamilton. 1992. A recent Black Rail record for Baja California. *Euphonia* 1(1): 19–21.

# NOTICE OF EXEMPTION

**To:** San Francisco County Clerk-Recorder
City and County of San Francisco
City Hall, Room 168
1 Dr. Carlton B. Goodlett Place
San Francisco, CA 94102-4678

**From:** Bay Area Toll Authority (BATA)
375 Beale Street, Suite 800
San Francisco, CA 94105

**Project Title:** The Bay Lights 360

**Project Location:** Bay Bridge, San Francisco, CA

**Project Location – City:** San Francisco **Project Location –County:** San Francisco

**Name of Public Agency Approving Project:** Bay Area Toll Authority

**Description of Project:** The Bay Lights is an existing art installation on the north side of the Bay Bridge's West Span and is the world's largest light-emitting diode (LED) light sculpture. The Bay Lights became operational March 5, 2013, was replaced in kind in the fall of 2015, and recommissioned in February 2016 as a permanent installation. The proposed Project consists of three main components: (1) the extension of the light sculpture for another 10 years to 2033; (2) the replacement of the light fixtures with newly updated and more robust fixtures and components while keeping the same technical details and intensity of the lights as the current installation; and (3) the addition of light fixtures to the driver's (inward-facing) side of the same suspension cables for a 360-degree view of the light sculpture.

**Name of Person or Agency Carrying Out Project:** Bay Area Toll Authority

**Exempt Status:** Class 1, Section 15301, Existing Facilities: Class 1 consists of the operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of existing or former use.

**Reasons why project is exempt:** The project is the extension of the light sculpture for another 10 years, removal and re-installation of the existing LED lights, and the addition of new lights on the driver's side of the same suspension cables to allow a 360-degree view of the LED light sculpture. The addition of the LED lights is considered a negligible expansion as the existing lights are already a prominent feature on the Bay Bridge and the hours of operation would remain the same.

Per Section 15300.2 of the California Environmental Quality Act (CEQA) Guidelines, it has been determined the project would not result in significant effects on the environment due to unusual circumstances. The project is not located on a hazardous waste site, will not damage scenic resources, cause a substantial adverse change in the significance of a historic resource, or result in a cumulative impact. For this reasons and those stated above, the project is exempt from the provisions of CEQA.

**Lead Agency Contact Person: Alix Bockelman** **Phone Number:** 415-778-5250

DocuSigned by:
**Signature:** [signature]
8445D8592178440...

**Date:** 7/21/2023 **Title:** Chief Deputy Executive Director

POSTED AUG 15 2023

TO SEP 27 2023

State of California - Department of Fish and Wildlife

# 2023 ENVIRONMENTAL DOCUMENT FILING FEE CASH RECEIPT

DFW 753.5a (REV. 01/01/23) Previously DFG 753.5a

Print [redacted] Finalize&Email

RECEIPT NUMBER:
38-08/15/2023-090

STATE CLEARINGHOUSE NUMBER *(If applicable)*

**SEE INSTRUCTIONS ON REVERSE. TYPE OR PRINT CLEARLY.**

| LEAD AGENCY | LEADAGENCY EMAIL | DATE |
|---|---|---|
| BAY AREA TOLL AUTHORITY (BATA) | | 08/15/2023 |
| COUNTY/STATE AGENCY OF FILING | | DOCUMENT NUMBER |
| SAN FRANCISCO COUNTY | | 2023-0000054 |

PROJECT TITLE

THE BAY LIGHTS 360

| PROJECT APPLICANT NAME | PROJECT APPLICANT EMAIL | | PHONE NUMBER |
|---|---|---|---|
| ALIX BOCKELMAN | | | (415) 778-5250 |
| PROJECT APPLICANT ADDRESS | CITY | STATE | ZIP CODE |
| 375 BEALE STREET, SUITE 800 | SAN FRANCISCO | CA | 94105 |

**PROJECT APPLICANT** *(Check appropriate box)*

☒ Local Public Agency ☐ School District ☐ Other Special District ☐ State Agency ☐ Private Entity

**CHECK APPLICABLE FEES:**

| | | |
|---|---|---|
| ☐ Environmental Impact Report (EIR) | $ 3,839.25 | $ |
| ☐ Mitigated/Negative Declaration (MND)(ND) | $ 2,764.00 | $ |
| ☐ Certified Regulatory Program (CRP) document - payment due directly to CDFW | $ 1,305.25 | $ |
| ☒ Exempt from fee | | |
| ☒ Notice of Exemption (attach) | | |
| ☐ CDFW No Effect Determination (attach) | | |
| ☐ Fee previously paid (attach previously issued cash receipt copy) | | |
| ☐ Water Right Application or Petition Fee (State Water Resources Control Board only) | $ 850.00 | $ |
| ☒ County documentary handling fee | $ 79.00 | $ 79.00 |
| ☐ Other | | $ |

**PAYMENT METHOD:**

☐ Cash ☐ Credit ☒ Check ☐ Other **TOTAL RECEIVED** $ 79.00

| SIGNATURE | AGENCY OF FILING PRINTED NAME AND TITLE |
|---|---|
| X [signature] | Mariedyne Nadonza Deputy Clerk |

ORIGINAL - PROJECT APPLICANT COPY - CDFW/ASB COPY - LEAD AGENCY COPY - COUNTY CLERK DFW 753.5a (Rev. 01012023)

# Assessing the Impacts of LED Lighting to Wildlife

*Requested by*
Scott Quinnell, Caltrans District 8

**January 23, 2019**

*The Caltrans Division of Research, Innovation and System Information (DRISI) receives and evaluates numerous research problem statements for funding every year. DRISI conducts Preliminary Investigations on these problem statements to better scope and prioritize the proposed research in light of existing credible work on the topics nationally and internationally. Online and print sources for Preliminary Investigations include the National Cooperative Highway Research Program (NCHRP) and other Transportation Research Board (TRB) programs, the American Association of State Highway and Transportation Officials (AASHTO), the research and practices of other transportation agencies, and related academic and industry research. The views and conclusions in cited works, while generally peer reviewed or published by authoritative sources, may not be accepted without qualification by all experts in the field. The contents of this document reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the California Department of Transportation, the State of California, or the Federal Highway Administration. This document does not constitute a standard, specification, or regulation. No part of this publication should be construed as an endorsement for a commercial product, manufacturer, contractor, or consultant. Any trade names or photos of commercial products appearing in this publication are for clarity only.*

## Table of Contents

# Executive Summary

## Background

Caltrans lacks the critical information necessary to assess the potential impacts of proposed light-emitting diode (LED) lighting projects to endangered, threatened and other sensitive wildlife species. Without consensus on appropriate metrics for assessing impacts to these animals, Caltrans districts will likely produce nonstandard impact analyses and also lack standardized measures to avoid or minimize lighting impacts in sensitive species areas.

Information that assesses the impacts, describes exemplary practices and identifies effective, readily available commercial products in connection with the use of LED lighting in sensitive species areas will help Caltrans develop a set of standard measures that could be incorporated into safety lighting projects where a protected species habitat is present.

To inform Caltrans' inquiry, CTC & Associates conducted two surveys. An initial nine-question survey sought information from a broad range of potential respondents in state departments of transportation (DOTs) and participants in the Wildlife, Fisheries and Transportation Listserv managed by the Center for Transportation and the Environment at North Carolina State University, which includes participants from domestic and international agencies. A follow-up survey sought additional information from selected agencies responding to the first survey that indicated active engagement with LED lighting. Consultations with researchers and a targeted examination of relevant literature supplemented survey findings.

## Summary of Findings

This Preliminary Investigation gathered information in three areas:

- Survey of practice.
- Consultation with researchers.
- Related research and resources.

### Survey of Practice

Fourteen state DOTs and a representative from a South African agency responded to an initial online survey. Two agencies provided additional information about agency practices in a follow-up survey. Key findings from respondents' feedback to both surveys are highlighted below.

#### Use of Commercial Wildlife-Friendly LED Lighting

Several agencies reported on the wildlife-friendly LED lighting their agencies use or are preparing to use. Florida DOT is developing wildlife-friendly lighting specifications that will include a list of accepted fixtures. Backlight, uplight and glare (BUG)-rated lighting is used by Georgia DOT. Minnesota DOT considers LED lighting to be wildlife-friendly when it is used with shrouds that have 0 uplight (full cutoff) or when the LEDs have a color temperature of 4000K or less.

#### Use of LED Lighting in Protected Wildlife Species Habitat

Nine of the responding DOTs—Connecticut, Florida, Illinois, Massachusetts, Minnesota, North Dakota, Tennessee, Utah and Wisconsin—reported the use of LED lighting in areas where

protected wildlife species habitat is present. Respondents from Connecticut, Florida and Minnesota indicated that LED lighting has impacted wildlife. Only three respondents—Montana, Oklahoma and Oregon—do not use LEDs in areas where protected wildlife species habitat is present.

Wildlife-Friendly Lighting Specifications

While none of the responding agencies has current specifications for LED or other lighting for use in sensitive species areas, the Florida DOT respondent reported on efforts underway to develop wildlife-friendly lighting specifications. Consultations with other divisions within the DOT, U.S. Fish and Wildlife Service, and Florida Fish and Wildlife Conservation Commission continue and are expected to result in a final specification available for use by June 2019. See page 7 for further details.

Case Studies

The brief case studies that begin on page 9 summarize feedback provided by respondents from Florida and Minnesota to a follow-up survey that gathered additional details about agency practices. The Florida DOT respondent provided a significant level of detail with regard to the lighting used, impact locations, species affected, and results of environmental reviews and consultations.

Other Agency Practices

Other agencies reported limited or no experience with wildlife-friendly lighting:

- Connecticut DOT's experience with wildlife-friendly lighting has been limited to project-specific issues, which include collaborating with the state's Wildlife Division in the Bureau of Natural Resources in connection with lighting for the Pearl Harbor Memorial Bridge in New Haven to mitigate impacts to avian migration patterns. Recently, the agency addressed concerns associated with LED lighting under a bridge near a ferry service and its potential impact to peregrine falcons nesting on the bridge.
- The Massachusetts DOT respondent noted the existence of federal lighting-related guidance in connection with the northern long-eared bat, but indicated that the agency does not use these provisions for "clearing" agency projects "as they are too restrictive on our construction activities."
- The Wisconsin DOT respondent is not aware of concerns about wildlife-friendly LED lighting, and the DOT has not investigated potential impacts to wildlife as a result of different lighting options.

Topic Areas Not Addressed by Respondents

None of the respondents offered information about completed research related to LED lighting and its impacts to wildlife, lighting alternatives, or conflicts among stakeholders.

**Consultation With Researchers**

The results of our contacts with researchers affiliated with four educational institutions that have experience investigating the impact of artificial light at night on wildlife and humans are summarized below.

- Brett Seymoure, a National Park Service postdoctoral fellow affiliated with Colorado State University, noted in a brief interview that spectrum and flicker are important issues to consider with regard to lighting and its impacts to humans and animals, as are the other components of light that contribute to animal health—brightness, color and polarization.

  Seymoure provided a collection of publications he describes as "foundational" that address lighting impacts across disciplines, with an emphasis on biology. These publications have been provided to Caltrans separately, along with preliminary drafts of articles that are being prepared for publication.

- Kamiel Spoelstra, a researcher affiliated with the Netherlands Institute of Ecology, pointed us to a web site containing the most recent publicly available research he has completed that addresses the effects of artificial light on nature (see page 15). He noted that a fact sheet on ecology and lighting will be published on this web site soon.

- Kevin Gaston, professor of biodiversity and conservation at University of Exeter (United Kingdom), directed us to a web site (see page 15) and provided a recent journal article. A citation for that article appears in the **Related Research and Resources** section of this report, along with other publications authored by Gaston.

- Travis Longcore, a University of Southern California researcher, reported that his research group will soon begin a project, with University of California, Davis in the lead, which will examine light conditions around underpasses and overpasses for wildlife to try to assess its influence. See page 24 for information about Longcore's recent research that produced "the first publicly available database showing how about two dozen different types of artificial lighting affect wildlife."

**Related Research and Resources**

An in-depth literature search identified a wealth of published research that addresses the biological impacts of artificial light at night to humans and animals. The relatively recent publications (typically published in the last 10 years) presented in this report do not represent a comprehensive examination of that primary topic, and instead provide a sampling of recent research examining LED lighting and its ecological and biological impacts, primarily to animals. The citations also examine, in a limited manner, lighting alternatives and other aspects of assessing the impact of artificial lighting (flickering light, light spectrum and measuring artificial light).

The citations that begin on page 17 are organized into eight categories:

- National guidance.
- State activities and guidance.
- Color temperature.
- Flickering artificial light.
- Impacts to animals and animal classes.
- Light spectrum.
- Lighting alternatives.
- Measuring artificial light.

## Gaps in Findings

The initial survey received a limited response from state DOTs and from the larger community participating in the Wildlife, Fisheries and Transportation Listserv. Many of the responding agencies reported limited experience with wildlife-friendly lighting.

As previously noted, Florida DOT is actively engaged in the development of wildlife-friendly lighting specifications (expected to be completed by June 2019).

There is significant research interest in the biological impacts of artificial light at night to humans and animals, and specific interest in the impacts of LED lighting. As this report indicates, journal articles and other guidance are in progress and research efforts are just beginning that may be of interest to Caltrans. Checking back with researchers and conducting periodic future examinations of relevant literature may uncover additional findings.

## Next Steps

Moving forward, Caltrans could consider:

- Consulting with the Florida DOT survey respondent to learn more about the agency's efforts to develop wildlife-friendly lighting specifications and how that experience could inform a similar Caltrans effort.
- Consulting with other survey respondents to learn more about agency practices, including:
    - Connecticut DOT's project-specific efforts to address wildlife impacts.
    - Georgia and Minnesota DOTs' use of BUG-rated lighting. The Minnesota DOT respondent provided a 5 rating for this type of lighting on a scale of 1 to 5 (where 1 = not at all successful and 5 = extremely successful).
- Contacting the agencies that reported use of LED lighting in protected wildlife species habitat to learn more about the lighting fixtures used and why they were selected.
- Reviewing the new database developed by a research team led by Travis Longcore that shows how different types of artificial lighting affect wildlife.
- Conducting an in-depth review of the publications cited in the **Related Research and Resources** section of this report to identify common themes and key findings that could inform Caltrans' efforts to develop a set of standard lighting-related measures.

# Detailed Findings

## Survey of Practice

### Survey Approach

Caltrans is seeking information from other state transportation agencies about the transition to light-emitting diode (LED) lighting and its impacts to wildlife, including species with federal and/or state protections, or other species of special concern. The topic areas below are of particular interest:

- Assessment of the impacts of LED lighting to wildlife.
- Lighting alternatives and modifications, and other measures to protect wildlife.
- Use of LED lighting in sensitive wildlife habitat.
- Feedback related to wildlife-friendly LED lighting.

To inform Caltrans' inquiry, CTC & Associates conducted two surveys. An initial nine-question survey sought information from a broad range of potential respondents:

- State department of transportation (DOT) members of the AASHTO Committee on Environment and Sustainability.
- Participants in the Wildlife, Fisheries and Transportation Listserv managed by the Center for Transportation and the Environment at North Carolina State University. Listserv managers note that the list "is intended to facilitate discussion among transportation and environmental professionals about emerging issues and best practices that improve the way ecological issues are addressed in surface transportation." At the time of survey distribution, the listserv had more than 350 subscribers.

A follow-up survey sought additional information from selected agencies responding to the first survey that indicated active engagement with LED lighting. The questions for both surveys are provided in Appendix A. The full text of survey responses is presented in a supplement to this report.

Survey results are supplemented by:

- Results of consultations with researchers. Summaries of email exchanges or brief interviews with four experts with regard to the impacts of artificial light begin on page 14.
- Findings from a literature search, which are provided in **Related Research and Resources** beginning on page 17.

### Summary of Survey Results

Fourteen state DOTs responded to the first online survey:

- Connecticut.
- Florida.
- Georgia.
- Illinois.
- Massachusetts.
- Minnesota.
- Montana.
- North Dakota.
- Oklahoma.
- Oregon.
- Tennessee.
- Utah.
- Washington.
- Wisconsin.

A representative from the South African Trans African Concessions (Pty) Limited (TRAC) also responded to the first survey. Respondents from Florida and Minnesota responded to the follow-up survey that gathered additional information about agency practices.

Respondents' feedback to both surveys is presented below in six topic areas:

- Use of commercial wildlife-friendly LED lighting.
- Use of LED lighting in protected wildlife species habitat.
- Wildlife-friendly lighting specifications.
- Case studies.
- Other agency practices.
- Topic areas not addressed by respondents.

## Use of Commercial Wildlife-Friendly LED Lighting

Four respondents reported on the wildlife-friendly LED lighting their agencies use:

- Florida DOT is "currently looking to incorporate these fixtures." See below for more information about wildlife-friendly lighting specifications in development.
- Georgia DOT uses backlight, uplight and glare (BUG)-rated lighting.
- Minnesota DOT generally considers LED lighting to be wildlife-friendly when it is used with shrouds that have 0 uplight (full cutoff) or when the LEDs have a color temperature of 4000K or less.
- The TRAC respondent from South Africa reported on complaints from a neighboring farm owner near a toll plaza about the color change of the streetlights, which led to owls in the area being killed by traveling vehicles. The agency "amended the lights" in an unspecified manner and "the problem seems to have been solved."

## Use of LED Lighting in Protected Wildlife Species Habitat

Nine of the responding DOTs—Connecticut, Florida, Illinois, Massachusetts, Minnesota, North Dakota, Tennessee, Utah and Wisconsin—reported the use of LED lighting in areas where protected wildlife species habitat is present. Respondents from Connecticut, Florida and Minnesota indicated that LED lighting has impacted wildlife. Only three respondents—Montana, Oklahoma and Oregon—do not use LEDs in areas where protected wildlife species habitat is present.

## Wildlife-Friendly Lighting Specifications

While none of the responding agencies has current specifications for LED or other lighting for use in sensitive species areas, the Florida DOT respondent reported on efforts underway to develop wildlife-friendly lighting specifications. These efforts are summarized below.

Florida DOT is working in coordination with the U.S. Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife Conservation Commission to address lighting concerns associated with

nesting sea turtles. The criteria and specifications in development are anticipated to be applicable for projects that may need to consider wildlife-friendly lighting for other species. The specifications in process will add new or revise existing content in two manuals:

> **Section 231, Lighting**, FDOT Design Manual, Florida Department of Transportation, January 2019.
> http://fdot.gov/roadway/FDM/current/2019FDM231Lighting.pdf
> This section of Florida DOT's Design Manual is now under revision to include wildlife-friendly lighting criteria.
>
> **Section 992, Highway Lighting Materials**, Standard Specifications for Road and Bridge Construction, Florida Department of Transportation, January 2019.
> http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2019/Files/119eBook.pdf
> See page 1203 of the manual (page 1211 of the PDF) for the section that will be revised to include specifications for luminaires for wildlife-friendly conventional lighting.

The respondent reported that the draft specifications and special provisions are being developed in collaboration with the agency's design, standards, specifications, construction and safety offices. Florida DOT continues to hold meetings with USFWS and the state wildlife commission, and expects that the process for official review and approval will result in a final form of the specifications that are available for use by June 2019.

Cited below are previously published research and other resources related to Florida DOT's evaluation of the impacts of lighting on nesting sea turtles:

> **Understanding, Assessing and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches**, Version 2, Blair E. Witherington, R. Erik Martin and Robbin N. Trindell, Florida Fish and Wildlife Conservation Commission, 2014.
> http://f50006a.eos-intl.net/ELIBSQL12_F50006A_Documents/TR-2Rev2.pdf
> *From the executive summary*:
>
> > The Solutions section underscores the use of BAT [best available technology] to manage lights from indoor and outdoor sources. Amber light emitting diodes (LEDs), red neon, and low-pressure sodium-vapor luminaires are good substitutes for more disruptive lighting near sea turtle nesting beaches. Effective Methods for Managing Light includes an overview of the current status and lessons learned. Solutions are provided for several categories of common light-pollution problems: swimming pools, parks, piers, sidewalks, walkways, bikeways, streetlights, parking facilities, decorative lights, and illuminated signs.
> > ….
> >
> > Appendices provide additional information on appropriate lamp types, lamp colors, fixture designs, and fixture mounting for various applications near sea turtle nesting beaches. They also provide information for contacting lighting companies that offer appropriate lighting fixtures and governmental and nongovernmental organizations that can help with sea turtle conservation. Last, they suggest responses to commonly encountered questions and comments regarding sea turtles and artificial lighting.

**"Installing Turtle-Friendly Lighting on Florida's Coastal Roadways,"** *Successes in Stewardship*, Federal Highway Administration, May 2012.
https://www.environment.fhwa.dot.gov/Pubs_resources_tools/publications/newsletters/may12nl.pdf
*From the newsletter*: …FDOT sought to identify a lighting design that would provide safety for pedestrians and vehicular traffic without affecting sea turtle nesting areas. In 2001, FDOT undertook a demonstration project that turned off existing roadway lighting and installed embedded LED lights along State Road A1A (SR A1A) in Boca Raton. In addition to the embedded LED lighting, FDOT installed low lighting along the bike path adjacent to the road to improve safety for cyclists. The project spanned the entire nesting season of 2001.

*Related Resource:*

**Impacts of Coastal Roadway Lighting on Endangered and Threatened Sea Turtles**, Michael Salmon, Jeanette Wyneken and Jerris Foote, Florida Department of Transportation, April 2003.
Citation at https://trid.trb.org/View/702625
This is the research study referenced in the newsletter article cited above.

## Case Studies

The brief case studies below summarize feedback provided by respondents from Florida and Minnesota to a follow-up survey that gathered additional details of agency practices.

### Case Study: Florida Department of Transportation

**Location of Impacts**

In Florida, lighting impacts are most often seen along coastal areas where nesting sea turtles are encountered. The agency has also had at least one interstate interchange project in Florida panther habitat that required additional consideration for impacts due to proposed lighting.

**Lighting Type Used**

The Florida Fish and Wildlife Conservation Commission recommends wildlife-certified light fixtures and bulbs that include pole-mounted luminaires (see **Related Resource** on page 11). This list includes LEDs (the respondent describes some of the LED products as having "dubious intensity"). Florida DOT intends to create a similar list of standard LED products that may be used without extensive coordination with other agencies.

**Species Impacted**

Florida panther (*Puma concolor coryi*)

Green turtle (sea turtle) (*Chelonia mydas*)

Hawksbill (sea turtle) (*Eretmochelys imbricata*)

Kemp's ridley sea turtle (*Lepidochelys kempii*)

Leatherback (sea turtle) (*Dermochelys coriacea*)

Loggerhead (sea turtle) (*Caretta caretta*)

**Extent of Impact**

For the panther reserve described above, where an interstate runs through the reserve, the impact area is adjacent to the right of way. This means that the impact area is within 50 feet of the luminaires. The agency encouraged designers to orient luminaires away from the impact area.

**Environmental Review or Consultation**

Typically, Florida DOT consults with USFWS on coastal projects regarding effects of lighting on sea turtles. The consultations typically result in commitments to various actions depending on the nature of the project, including:

- Limiting sky glow.
- Avoiding nighttime lighting during nesting season.
- Ensuring nighttime lighting does not trespass onto nesting areas.
- Providing sea turtle-friendly lighting through use of downward directed, full cutoff, well-shielded fixtures with low-pressure sodium or amber LED lamps that allow no emission of light above the horizontal plane of the fixture.

Lighting designs are typically reviewed by both agencies.

The DOT has completed consultation for one project with lighting adjacent to the panther reserve previously described.

**Lighting Alternatives and Modifications**

*Lighting filter*. Filters have been used in the past but not on a standardized basis; the DOT has no plans to pursue continued use.

*Shielding*. This is a common practice for Florida DOT but is insufficient by itself. The respondent noted that it is difficult to determine the success of this practice because it is not typically used individually, though did provide a 3 rating on a scale of 1 to 5 (where 1 = not at all successful and 5 = extremely successful).

*Luminaires with low backlight, uplight and glare (BUG) ratings*. Agency use of BUG-rated fixtures is a common practice, even outside wildlife impact areas. The respondent gave this lighting option a 3 rating.

Other modifications:

- In Florida, there are sections of roadway where the lighting is disconnected during sea turtle hatching season. The agency does not consider this to be a successful mitigation.
- Florida DOT does not use adjustments based on the presence of vehicles on the roadway, ambient nighttime light or timers.

**Nonlighting Measures**

Florida DOT has used the following practices to supplement its lighting-related measures:

- Posted signs about possible wildlife in the area (bear, panther).
- Provided fencing to discourage wildlife from coming onto limited access facilities.

**Nonlighting Measures (continued)**

- Provided wildlife crossings in various forms (box or elliptical culverts, “dry shelves” adjacent to bridges or culverts where the original structure is intended for drainage purposes, and wildlife-specific structures where a drainage feature doesn’t exist.

**Public Comments**

The respondent noted that any public comments received in response to implementation of wildlife-friendly LED lighting would be directed to DOT districts. Lacking a central repository for these comments, additional investigation would be required to determine if public comments have been received by the agency.

**Related Resource**

**Fixtures and Bulbs: Certified Wildlife Lighting**, Florida Fish and Wildlife Conservation Commission, 2018.
http://myfwc.com/conservation/you-conserve/lighting/certified/
*From the web site*: The fixtures and bulbs on the pages listed below have all been reviewed through the Wildlife Lighting Certification Process. To be Wildlife Lighting Certified, the required options and bulleted recommendations for each fixture or bulb must also be met. They are categorized by use.

## Case Study: Minnesota Department of Transportation

**Location of Impacts**

Various and unspecified.

**Lighting Type Used**

Various and unspecified. The agency generally considers LED lighting to be wildlife-friendly when it is used with shrouds that have 0 uplight (full cutoff) or when the LEDs have a color temperature of 4000K or less.

**Species Impacted**

Northern long-eared bat (*Myotis septentrionalis*)

Western prairie fringed orchid (*Platanthera praeclara*)

Unspecified birds

**Environmental Review or Consultation**

In some cases, USFWS has identified areas where LEDs should not be used to avoid impacting the species of moth that pollinates the western prairie fringed orchid.

USFWS has also identified avoidance and minimization measures (AMMs) for lighting used on projects that may affect northern long-eared bats. (See page 12 for more information about the AMMs associated with the northern long-eared bat.)

**Lighting Alternatives and Modifications**

Luminaires with low BUG ratings are used as a common practice. The respondent provided a 5 rating on a scale of 1 to 5 (where 1 = not at all successful and 5 = extremely successful).

**Lighting Alternatives and Modifications (continued)**

Other modifications:

- In rare cases, the agency may opt not to use LEDs. The respondent did not indicate the type of lighting used in their place.
- Minnesota DOT does not use adjustments based on the presence of vehicles on the roadway, ambient nighttime light or timers.

**Nonlighting Measures**

None reported.

**Public Comments**

Some members of the public have commented that lighting is still too bright.

**Related Resource**

**Roadway Lighting Products**, Approved/Qualified Products, Minnesota Department of Transportation, 2018.
http://www.dot.state.mn.us/products/roadwaylighting/index.html
This web site provides access to a hyperlinked site map of approved lighting products and lists of approved products for light foundations, lighting hardware, luminaires, rodent intrusion barrier, service cabinets, bridge navigation lanterns and air obstruction lights.

## Other Agency Practices

Three respondents offered information about current agency practices:

- *Connecticut*. The DOT's experience has been limited to project-specific issues, which include collaborating with the state's Wildlife Division in the Bureau of Natural Resources in connection with lighting for the Pearl Harbor Memorial Bridge (more commonly known as the Q Bridge) in New Haven to address concerns about impacts to avian migration patterns. Recently, the agency addressed concerns associated with LED lighting under a bridge near a ferry service and its potential impact to peregrine falcons nesting on the bridge.
- *Massachusetts*. The respondent noted the existence of federal lighting-related guidance in connection with the northern long-eared bat, but indicated that the agency does not use these provisions for "clearing" agency projects "as they are too restrictive on our construction activities." The citation below provides the guidance referenced by the respondent:

  **Range-Wide Programmatic Consultation for Indiana Bat and Northern Long-Eared Bat: Avoidance and Minimization Measures**, Endangered Species, U.S. Fish and Wildlife Service, January 2018.
  https://www.fws.gov/midwest/endangered/section7/fhwa/pdf/AppC_AMMsRevisedFeb2018.pdf
  *From the document*: For projects to be covered by the Programmatic Biological Opinion (BO), specific avoidance and minimization measures (AMMs) related to the Indiana bat and northern long-eared bat (NLEB) will be implemented where applicable. AMMs, if adopted under appropriate circumstances, are expected to reduce the potential impacts of the proposed action on both bat species.

….

The following AMMs are necessary to avoid and minimize impacts to the Indiana bat and NLEB, and where applicable, are required for projects using the range-wide programmatic consultation.

….

***Lighting***

Lighting AMM 1. Direct temporary lighting away from suitable habitat during the active season.

Lighting AMM 2. When installing new or replacing existing permanent lights, use downward-facing, full cut-off lens lights (with same intensity or less for replacement lighting); or for those transportation agencies using the BUG system developed by the Illuminating Engineering Society, the goal is to be as close to 0 for all three ratings with a priority of "uplight" of 0 and "backlight" as low as practicable.

- *Wisconsin*. To the respondent's knowledge, concerns about wildlife-friendly LED lighting have not been raised in Wisconsin, nor has the DOT investigated potential impacts to wildlife as a result of different lighting options.

## Topic Areas Not Addressed by Respondents

None of the respondents offered information about three topic areas addressed in the survey:

- *Research*. None of the responding agencies reported on completed research that examines the effects of LED lighting and its impacts to wildlife.
- *Lighting alternatives*. Aside from LED lighting, none of the respondents have identified a cost-effective, energy-efficient lighting alternative that avoids or minimizes impacts to wildlife.
- *Conflicts among stakeholders*. None of the responding agencies reported on conflicts between competing stakeholders as a result of implementing wildlife-friendly LED lighting.

# Consultation With Researchers

We contacted researchers affiliated with four educational institutions—Colorado State University, Netherlands Institute of Ecology, University of Exeter and University of Southern California—that have experience investigating the impact of artificial light at night on wildlife and humans. Below are summaries of email or phone queries posed to these researchers, and links or references to relevant resources.

## Colorado State University

Brett Seymoure, a National Park Service postdoctoral fellow affiliated with Colorado State University, noted in a brief interview that spectrum and flicker are important issues to consider with regard to lighting and its impacts to humans and animals, as are the other components of light that contribute to animal health—brightness, color and polarization.

Seymoure provided a collection of publications he describes as "foundational" that address lighting impacts across disciplines, with an emphasis on biology. These publications have been provided to Caltrans separately, along with preliminary drafts of articles that are being prepared for publication.

*Contact*: Brett Seymoure, Postdoctoral Fellow, Department of Biology and Department of Fish, Wildlife and Conservation Biology, Colorado State University and National Park Service, brett.seymoure@colostate.edu.

*Related Resources*:

> **Brett M. Seymoure**, Behavioral and Sensory Ecology in the 21st Century, undated.
> http://www.brettseymoure.com
> *From the web site*: I study how animals have adapted to and are affected by their environment. How has the environment selected for different visual traits? Specifically, how does environmental lighting affect organisms' coloration and vision? How and why have different visual systems evolved? How does anthropogenic light affect visually guided behavior in animals? I approach these questions from a sensory and behavioral ecological perspective to shed light onto evolutionary and conservation biology.

## Netherlands Institute of Ecology

Kamiel Spoelstra, a researcher affiliated with the Netherlands Institute of Ecology, pointed us to the web site cited below for the most recent publicly available research he has completed that addresses the effects of artificial light on nature. He noted that a fact sheet on ecology and lighting will be published on this web site soon.

*Contact*: Kamiel Spoelstra, Postdoctoral Researcher in Animal Ecology, Netherlands Institute of Ecology, 31-317-473454, k.spoelstra@nioo.knaw.nl.

*Related Resource*:

**LichtOpNatuur: What Are the Effects of Artificial Light on Nature?**, Kamiel Spoelstra and Roy van Grunsven, undated.
www.lichtopnatuur.org
This web site provides access to in-depth research and a description of monitoring efforts that address the impacts of artificial light on birds, moths, amphibians, mammals and plants. Links to publications, presentations and other media are also provided (some in Dutch).

## University of Exeter (United Kingdom)

Kevin Gaston, professor of biodiversity and conservation at University of Exeter, directed us to the web site cited below and provided a recent journal article (see "Nature, Extent and Ecological Implications of Night-Time Light From Road Vehicles" on page 24).

*Contact*: Kevin Gaston, Professor of Biodiversity and Conservation, University of Exeter, 01-326-255810, k.j.gaston@exeter.ac.uk.

*Related Resource*:

**Kevin J. Gaston**, Professor of Biodiversity and Conservation at University of Exeter, 2018.
http://kevingaston.com/
This web site provides information about Gaston's research activities, which he describes as:

> … basic, strategic and applied research in ecology. This is presently centred around three main issues:
>
> - Common ecology – the study of common species, the determinants of commonness and its consequences.
> - Nighttime ecology – the study of the abundance, distribution and interactions of species during the night (including the consequences of anthropogenic pressures such as artificial nighttime lighting).
> - Personalised ecology – the study of the direct interactions between individual people and nature, their causes and consequences.

The web site also provides links to relevant publications.

## University of Southern California

Travis Longcore, a University of Southern California researcher, reported that his research group will soon begin a project, with University of California, Davis in the lead, which will examine light conditions around underpasses and overpasses for wildlife to try to assess its influence. He noted that "[m]uch of my current research is about measuring light conditions properly for ecological studies and connect[ing] the ground-based measurements to satellite measurements." See page 24 for information about Longcore's recent research that produced "the first publicly available database showing how about two dozen different types of artificial lighting affect wildlife."

In addition to publications cited in the **Related Research and Resources** section of this report, Longcore provided a draft article planned for publication in *LED Professional Review*. The published article is cited in *Related Resources* below.

*Contact*: Travis Longcore, Assistant Professor of Architecture, Spatial Sciences and Biological Sciences, School of Architecture, University of Southern California, 213-821-1310, longcore@usc.edu.

*Related Resources*:

**Longcore Landscape and Urban Nature Lab**, USC School of Architecture and USC Spatial Sciences Institute, University of Southern California, undated.
https://www.travislongcore.net
*From the web site*:

> Formed in 2015, the Landscape & Urban Nature Lab is based on the premise that empirical analysis using a spatial framework can provide a common platform to address important issues of ecological management, stewardship, and design. The lab focuses on cities because they represent an increasing proportion of human settlements on the planet, where nature can either be incorporated and encouraged or polluted and excluded, with dramatically different outcomes for people, biodiversity, and the environment as a whole.
>
> Current research efforts focus on four themes: 1) light pollution and its impacts on species, ecosystems, and people; 2) historical ecology as a means to understand landscapes and inspire restoration and management; 3) spatial ecology and conservation at the intersection of cities and nature; and 4) urban bioresource management using spatial tools and approaches such as geodesign.
>
> The lab operates virtually, with personnel located in the USC School of Architecture and the USC Spatial Sciences Institute and with many off-campus collaborators.

Links to relevant publications are available at https://travislongcore.net/light-pollution/.

**"Hazard or Hope? LEDs and Wildlife,"** Travis Longcore, *LED Professional Review*, Vol. 70, pages 52-57, November/December 2018.
https://www.researchgate.net/profile/Travis_Longcore/publication/329174799_Hazard_or_Hope_LEDs_and_Wildlife_LED_Professional_Review/links/5bfa21d3299bf1a0203140e3/Hazard-or-Hope-LEDs-and-Wildlife-LED-Professional-Review.pdf
*From the abstract*: The introduction and widespread uptake of LEDs as outdoor lighting has caused no small amount of concern amongst conservation biologists. The prevailing impression that LEDs are always blue-white is well founded as adoption of LEDs for streetlights were invariably high color temperatures and with the deterioration of phosphors the blue wavelengths penetrated even more. But LEDs do have characteristics that differentiate them from other light sources and may allow for the reduction of environmental effects of lighting on species and habitats: direction, duration, intensity and spectrum.

# Related Research and Resources

An in-depth literature search identified a wealth of published research that addresses the biological impacts of artificial light at night to humans and animals. The relatively recent publications (typically, published in the last 10 years) presented below do not represent a comprehensive examination of that primary topic, and instead provide a sampling of recent research examining LED lighting and its ecological and biological impacts, primarily to animals. The citations below also examine, in a limited manner, lighting alternatives and other aspects of assessing the impact of artificial lighting (flickering light, light spectrum and measuring artificial light).

The citations below are organized into eight categories:

- National guidance.
- State activities and guidance.
- Color temperature.
- Flickering artificial light.
- Impacts to animals and animal classes.
- Light spectrum.
- Lighting alternatives.
- Measuring artificial light.

## National Guidance

**Wildlife Lighting**, Florida Fish and Wildlife Conservation Commission and the U.S. Fish and Wildlife Service, undated.
http://myfwc.com/conservation/you-conserve/lighting/
*From the web site*: The Wildlife Lighting Certification Program is a cooperative effort between the Florida Fish and Wildlife Conservation Commission and the U.S. Fish and Wildlife Service designed to educate the members of the public, the building industry and government officials how to minimize adverse impacts to wildlife by using proper lighting methods.

**Artificial Night Lighting and Protected Lands: Ecological Effects and Management Approaches**, Travis Longcore and Catherine Rich, National Park Service, May 2016.
https://www.uv.es/salvemlanit/Documents/Longcore-Artificial-night-lighting-protected-lands.pdf
*From the introduction*: This document is divided into two sections. The first section reviews the effects of artificial night lighting on major habitat types. No single solution can mitigate all adverse effects of artificial night lighting. We therefore attempt to generalize the concerns that typify each biome. The second section provides recommendations for management approaches to minimize impacts from lighting. We address the characteristics of lights in terms of need, spectrum, intensity, direction, and duration, with reference to biomes in which each method of control would be applicable. This discussion addresses common lighting applications—roadways, parking, and walkways—as well as specialized situations like night hiking and mountain biking, vanity lighting, communication towers, and light-assisted fishing.

**2016 Animal Responses to Light Meeting Report**, Solid-State Lighting Program, U.S. Department of Energy, June 2016.
https://www.energy.gov/sites/prod/files/2016/06/f32/ssl_animalresponse_jun2016.pdf
*From the introduction:*

> On April 19th, 2016, ten experts in fields related to animal physiological responses to light gathered with light-emitting diode (LED) manufacturers and the DOE [Department of Energy] Solid-State Lighting (SSL) Program for a discussion of common research themes,

research challenges and paths forward to better understand the broad topic of animal responses to light. The meeting, hosted by the Midwest Energy Efficiency Alliance (MEEA) in Chicago, Illinois, commenced with "soapbox" presentations, where each participant was invited to give a short presentation describing their field of expertise and forward-looking research concepts. This was followed by a general discussion of research and development opportunities for SSL that potentially benefit productivity and wellbeing of livestock and minimize impacts of light on wildlife and landscape ecology. This report is a summary of the input provided at this meeting and the subsequent discussions.

## State Activities and Guidance

Cited below are a Kansas DOT research report that provides information to assist with the agency's transition to LED lighting, and research proposed by Ohio DOT that considers the use of LEDs in ecologically sensitive areas. See page 8 for publications associated with Florida DOT's research efforts in this topic area.

### Kansas

**Kansas Highway LED Illumination Manual: A Guide for the Use of LED Lighting Systems**, Hongyi Cai, Kansas Department of Transportation, December 2015.
http://www.ksdot.org/Assets/wwwksdotorg/bureaus/kdotlib/KU156.pdf
This research project designed to assist Kansas DOT with its implementation of LED roadway lighting describes the LED lighting specified for Lighting Zone 1 (dark ambient lighting used in state parks, recreation areas and wildlife preserves).

### Ohio

**Proposed Research: Ecological Design Rules for Roadway Lighting**, RFP Solicitation Number 2019-07, Ohio Department of Transportation, posted January 15, 2018.
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/RFP/Documents/2019-RFPs/2019-07_EcologicalRoadwayLighting.pdf
This research proposal was part of Ohio DOT's solicitation for proposals for fiscal year 2019, with responses due March 2, 2018. *From the proposal*:

> **Problem Statement**
> Currently, the Ohio Department of Transportation (ODOT) designs roadway lighting in agricultural areas to produce adequate pavement illumination per the Traffic Engineering Manual (TEM), which cites industry standard IES [Illuminating Engineering Society] RP-8. Typically, designers give little or no consideration to light trespass during roadway lighting design. All ODOT lighting installations run dusk-to-dawn with no programmed dimming or light curfews. An upcoming addition to the TEM will address light trespass in agricultural areas by recommending a light trespass illuminance limit of 0.1 foot-candle on agricultural fields.
> The proposed research will focus on the effects that LED lighting has on wildlife in ecologically sensitive urban and rural areas. Limited but ongoing academic research suggests that the quantity and spectra of LED lighting have negative (and occasionally positive) effects on terrestrial and aquatic ecosystems. These effects can influence individual species and the overall ecosystem health. Lighting that illuminates the roadway pavement is engineered lighting. Industry standards provide design pavement illuminance values, and it is difficult to deviate from these established engineering standards without

reasonable justification. Well-executed research targeting this issue can serve as such justification for ODOT roadway lighting design changes that relate to ecological effects.

**Goals and Objectives**
The goal of this research is to establish design rules for roadway lighting in ecologically sensitive urban and rural areas. Objectives include:

- Determining the effects of roadway lighting on various wildlife areas:
    - What type of animals are affected by light?
    - How do attributes of the site play a role in the effect?

## Color Temperature

**"Light at Night Disrupts Nocturnal Rest and Elevates Glucocorticoids at Cool Color Temperatures,"** Valentina J. Alaasam, Richard Duncan, Stefania Casagrande, Scott Davies, Abhijaat Sidher, Brett Seymoure, Yantao Shen, Yong Zhang and Jenny Q. Ouyang, *Journal of Experimental Zoology Part A,* May 2018 (epublication ahead of print).
Citation at https://doi.org/10.1002/jez.2168
*From the abstract*: Nighttime light pollution is quickly becoming a pervasive, global concern. Since the invention and proliferation of light-emitting diodes (LED), it has become common for consumers to select from a range of color temperatures of light with varying spectra. Yet, the biological impacts of these different spectra on organisms remain unclear. We tested if nighttime illumination of LEDs, at two commercially available color temperatures (3000 and 5000 K) and at ecologically relevant illumination levels affected body condition, food intake, locomotor activity, and glucocorticoid levels in zebra finches (*Taeniopygia guttata*). We found that individuals exposed to 5000 K light had higher rates of nighttime activity (peaking after 1 week of treatment) compared to 3000 K light and controls (no nighttime light). Birds in the 5000 K treatment group also had increased corticosterone levels from pretreatment levels compared to 3000 K and control groups but no changes in body condition or food intake. Individuals that were active during the night did not consequently decrease daytime activity. This study adds to the growing evidence that the spectrum of artificial light at night is important, and we advocate the use of nighttime lighting with warmer color temperatures of 3000 K instead of 5000 K to decrease energetic costs for avian taxa.

**"LED Lighting Increases the Ecological Impact of Light Pollution Irrespective of Color Temperature,"** S. M. Pawson and M. K.-F. Bader, *Ecological Applications*, Vol. 24, No. 7, pages 1561-1568, October 2014.
https://esajournals.onlinelibrary.wiley.com/doi/full/10.1890/14-0468.1
*From the abstract:* Recognition of the extent and magnitude of night-time light pollution impacts on natural ecosystems is increasing, with pervasive effects observed in both nocturnal and diurnal species. Municipal and industrial lighting is on the cusp of a step change where energy-efficient lighting technology is driving a shift from "yellow" high-pressure sodium vapor lamps (HPS) to new "white" light-emitting diodes (LEDs). We hypothesized that white LEDs would be more attractive and thus have greater ecological impacts than HPS due to the peak UV-green-blue visual sensitivity of nocturnal invertebrates. Our results support this hypothesis; on average LED light traps captured 48% more insects than were captured with light traps fitted with HPS lamps, and this effect was dependent on air temperature (significant light × air temperature interaction). We found no evidence that manipulating the color temperature of white LEDs would minimize the ecological impacts of the adoption of white LED lights. As such, large-scale adoption of energy-efficient white LED lighting for municipal and industrial use may

exacerbate ecological impacts and potentially amplify phytosanitary pest infestations. Our findings highlight the urgent need for collaborative research between ecologists and electrical engineers to ensure that future developments in LED technology minimize their potential ecological effects.

## Flickering Artificial Light

**"Potential Biological and Ecological Effects of Flickering Artificial Light,"** Richard Inger, Jonathan Bennie, Thomas W. Davies and Kevin J. Gaston, *PLoS ONE*, Vol. 9, No. 5, May 2014.
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0098631
*From the abstract*: Organisms have evolved under stable natural lighting regimes, employing cues from these to govern key ecological processes. However, the extent and density of artificial lighting within the environment has increased recently, causing widespread alteration of these regimes. Indeed, night-time electric lighting is known significantly to disrupt phenology, behaviour, and reproductive success, and thence community composition and ecosystem functioning. Until now, most attention has focussed on effects of the occurrence, timing, and spectral composition of artificial lighting. Little considered is that many types of lamp do not produce a constant stream of light but a series of pulses. This flickering light has been shown to have detrimental effects in humans and other species. Whether a species is likely to be affected will largely be determined by its visual temporal resolution, measured as the critical fusion frequency. That is the frequency at which a series of light pulses are perceived as a constant stream. Here we use the largest collation to date of critical fusion frequencies, across a broad range of taxa, to demonstrate that a significant proportion of species can detect such flicker in widely used lamps. Flickering artificial light thus has marked potential to produce ecological effects that have not previously been considered.

## Impacts to Animals and Animal Classes

The publications below address the impacts of LED and other lighting types on arthropods, bats, birds, insects and mice.

### Arthropods

**"Tuning the White Light Spectrum of Light Emitting Diode Lamps to Reduce Attraction of Nocturnal Arthropods,"** Travis Longcore, Hannah L. Aldern, John F. Eggers, Steve Flores, Lesly Franco, Eric Hirshfield-Yamanishi, Laina N. Petrinec, Wilson A. Yan and André M. Barroso, *Philosophical Transactions of the Royal Society; Series B, Biological Sciences,* Vol. 370, No. 1667, May 2015.
http://rstb.royalsocietypublishing.org/content/royptb/370/1667/20140125.full.pdf
*From the abstract:* Artificial lighting allows humans to be active at night, but has many unintended consequences, including interference with ecological processes, disruption of circadian rhythms and increased exposure to insect vectors of diseases. Although ultraviolet and blue light are usually most attractive to arthropods, degree of attraction varies among orders. With a focus on future indoor lighting applications, we manipulated the spectrum of white lamps to investigate the influence of spectral composition on number of arthropods attracted. We compared numbers of arthropods captured at three customizable light-emitting diode (LED) lamps (3510, 2704 and 2728 K), two commercial LED lamps (2700 K), two commercial compact fluorescent lamps (CFLs; 2700 K) and a control. We configured the three custom LEDs to minimize invertebrate attraction based on published attraction curves for honeybees and moths. Lamps were placed with pan traps at an urban and two rural study sites in Los Angeles,

California. For all invertebrate orders combined, our custom LED configurations were less attractive than the commercial LED lamps or CFLs of similar colour temperatures. Thus, adjusting spectral composition of white light to minimize attracting nocturnal arthropods is feasible; not all lights with the same colour temperature are equally attractive to arthropods.

## Bats

**"Transition From Conventional to Light-Emitting Diode Street Lighting Changes Activity of Urban Bats,"** Daniel Lewanzik and Christian C. Voigt, *Journal of Applied Ecology,* Vol. 54, No. 1, pages 264-271, February 2017.
Citation at https://besjournals.onlinelibrary.wiley.com/doi/abs/10.1111/1365-2664.12758
*From the summary:*

1. Light pollution is rapidly increasing and can have deleterious effects on biodiversity, yet light types differ in their effect on wildlife. Among the light types used for street lamps, light-emitting diodes (LEDs) are expected to become globally predominant within the next few years.
2. In a large-scale field experiment, we recorded bat activity at 46 street lights for 12 nights each and investigated how the widespread replacement of conventional illuminants by LEDs affects urban bats: we compared bat activity at municipal mercury vapour (MV) street lamps that were replaced by LEDs with control sites that were not changed.
3. *Pipistrellus pipistrellus* was the most frequently recorded species; it was 45% less active at LEDs than at MV street lamps, but the activity did not depend on illuminance level. Light type did not affect the activity of *Pipistrellus nathusii*, *Pipistrellus pygmaeus* or bats in the *Nyctalus/Eptesicus/Vespertilio* (NEV) group, yet the activity of *P. nathusii* increased with illuminance level. Bats of the genus *Myotis* increased activity 4·5-fold at LEDs compared with MV lights, but illuminance level had no effect.
4. Decreased activity of *P. pipistrellus*, which are considered light tolerant, probably paralleled insect densities around lights. Further, our results suggest that LEDs may be less repelling for light-averse *Myotis* spp. than MV lights. Accordingly, the transition from conventional lighting techniques to LEDs may greatly alter the anthropogenic impact of artificial light on urban bats and might eventually affect the resilience of urban bat populations.
5. *Synthesis and applications*. At light-emitting diodes (LEDs), the competitive advantage—the exclusive ability to forage on insect aggregations at lights—is reduced for light-tolerant bats. Thus, the global spread of LED street lamps might lead to a more natural level of competition between light-tolerant and light-averse bats. This effect could be reinforced if the potential advantages of LEDs over conventional illuminants are applied in practice: choice of spectra with relatively little energy in the short wavelength range; reduced spillover by precisely directing light; dimming during low human activity times; and control by motion sensors. Yet, the potential benefits of LEDs could be negated if low costs foster an overall increase in artificial lighting.

**"Dark Matters: The Effects of Artificial Lighting on Bats,"** E. G. Rowse, D. Lewanzik, E. L. Stone, S. Harris and G. Jones, *Bats in the Anthropocene: Conservation of Bats in a Changing World*, C. Voigt and T. Kingston (editors), Springer Nature, pages 187-213, 2016.
https://link.springer.com/chapter/10.1007/978-3-319-25220-9_7
*From the abstract:* While artificial lighting is a major component of global change, its biological impacts have only recently been recognised. Artificial lighting attracts and repels animals in

taxon-specific ways and affects physiological processes. Being nocturnal, bats are likely to be strongly affected by artificial lighting. Moreover, many species of bats are insectivorous, and insects are also strongly influenced by lighting. Lighting technologies are changing rapidly, with the use of light-emitting diode (LED) lamps increasing. Impacts on bats and their prey depend on the light spectra produced by street lights; ultraviolet (UV) wavelengths attract more insects and consequently insectivorous bats. Bat responses to lighting are species-specific and reflect differences in flight morphology and performance; fast-flying aerial hawking species frequently feed around street lights, whereas relatively slow-flying bats that forage in more confined spaces are often light-averse. Both high-pressure sodium and LED lights reduce commuting activity by clutter-tolerant bats of the genera *Myotis* and *Rhinolophus*, and these bats still avoided LED lights when dimmed. Light-induced reductions in the activity of frugivorous bats may affect ecosystem services by reducing dispersal of the seeds of pioneer plants and hence reforestation. Rapid changes in street lighting offer the potential to explore mitigation methods such as part-night lighting (PNL), dimming, directed lighting, and motion-sensitive lighting that may have beneficial consequences for light-averse bat species.

**Bats and Lighting: Overview of Current Evidence and Mitigation**, Emma L. Stone, Bats and Lighting Research Project, University of Bristol, 2013.
http://www.batsandlighting.co.uk/downloads/lightingdoc.pdf
*From the foreword*: These guidelines have been drafted with input from experts in lighting (Institute of Lighting Professionals), bat surveys, ecology and mitigation (Bat Conservation Trust), legislation (Natural England) and bat research and mitigation (University of Bristol) to provide the best current evidence and thinking in the field of mitigation of the impacts of lighting on bats. This document is aimed at ecologists, lighting engineers, architects, planners and ecologists in Local Authorities and Statutory Nature Conservation Organisations such as Natural England, Scottish Natural Heritage or Natural Resources Wales.

## Birds

**"Effects of Nocturnal Illumination on Life-History Decisions and Fitness in Two Wild Songbird Species,"** Maaike de Jong, Jenny Q. Ouyang, Arnaud Da Silva, Roy H. A. Van Grunsven, Bart Kempenaers, Marcel E. Visser and Kamiel Spoelstra, *Philosophical Transactions of the Royal Society; Series B, Biological Sciences,* Vol. 370, No. 1667, May 2015.
http://rstb.royalsocietypublishing.org/content/royptb/370/1667/20140128.full.pdf
*From the abstract:* The effects of artificial night lighting on animal behaviour and fitness are largely unknown. Most studies report short-term consequences in locations that are also exposed to other anthropogenic disturbance. We know little about how the effects of nocturnal illumination vary with different light colour compositions. This is increasingly relevant as the use of LED lights becomes more common, and LED light colour composition can be easily adjusted. We experimentally illuminated previously dark natural habitat with white, green and red light, and measured the effects on life-history decisions and fitness in two free-living songbird species, the great tit (*Parus major*) and pied flycatcher (*Ficedula hypoleuca*) in two consecutive years. In 2013, but not in 2014, we found an effect of light treatment on lay date, and of the interaction of treatment and distance to the nearest lamp post on chick mass in great tits but not in pied flycatchers. We did not find an effect in either species of light treatment on breeding densities, clutch size, probability of brood failure, number of fledglings and adult survival. The finding that light colour may have differential effects opens up the possibility to mitigate negative ecological effects of nocturnal illumination by using different light spectra.

## Insects

**"Quantifying the Attractiveness of Broad-Spectrum Street Lights to Aerial Nocturnal Insects,"** Andrew Wakefield, Moth Broyles, Emma L. Stone, Stephen Harris and Gareth Jones, *Journal of Applied Ecology*, Vol. 55, pages 714-722, 2018.
https://besjournals.onlinelibrary.wiley.com/doi/pdf/10.1111/1365-2664.13004
*From the abstract*:

1. Sodium street lights, dominated by long wavelengths of light, are being replaced by broad-spectrum, white lights globally, in particular light-emitting diodes (LEDs). These white lights typically require less energy to operate and are therefore considered "eco-friendly." However, little attention has been paid to the impacts white lights may have upon local wildlife populations.
2. We compared insect attraction to orange (high-pressure sodium, HPS) and white (metal halide, MH and LED) street lights experimentally using portable street lights and custom-made flight intercept traps.
3. Significantly more (greater than five times as many) insects were attracted to white MH street lights than white (4,250 K) LED and HPS lights. There was no statistical difference in the numbers of insects attracted to LED and HPS lights for most taxa caught. However, rarefaction shows a greater diversity of insects caught at LED than HPS lights.
4. *Policy implications*. With the current, large-scale conversion to white light-emitting diode (LED) lighting, our results give insight into how changes to street light technology may affect wildlife populations and communities. We recommend avoiding metal halide light installations as they attract many more insects than competing technologies. We highlight the need to tailor LED lighting to prevent disturbances across multiple insect taxa.

## Mice

**"The Influence of Low-Powered Family LED Lighting on Eyes in Mice Experimental Model,"** Mei-Ling Peng, Cheng-Yu Tsai, Chung-Liang Chien, John Ching-Jen Hsiao, Shuan-Yu Huang, Ching-Ju Lee, Hsiang-Yin Lin, Yang-Cheng Wen and Kuang-Wen Tseng, *Life Science Journal,* Vol. 9, No. 1, pages 477-482, 2012.
http://www.lifesciencesite.com/lsj/life0901/072_8366life0901_477_482.pdf
*From the abstract:* Ocular tissue damage because of exposure to visible light has been demonstrated by the results of human and animal studies. The short-wavelength visible light between 430 nm [nanometers] to 500 nm (blue light) is especially associated with retina damage. Recently, new powerful sources and relatively inexpensive blue energy of LED (light emitting diodes) family lamps in home illumination are available. The aim of this study is to investigate the effects of illumination source from the low-powered and the conscious spectrum source of LED family lamps on retina tissues. The illumination source of LED family lamps was analyzed from 300 nm to 800 nm using an UV-visible spectrophotometer. In animal experiments, young adult mice were assigned to expose to family LED light for 2h[ours] every day ranging 2 to 4 weeks or light environment using LED family lamps for 39 weeks. After LED light treatment, sections of eyes were stained with hematoxylin and examined using histopathology. The data clearly demonstrated irradiation of the white LED is above 400 nm and is not within the ultraviolet light region. However, the analysis of spectrum distribution demonstrated that the family LED lighting exhibited power-peak at 450 nm is within the blue light region. Histological results showed that the photoreceptor layer is significantly reduced in thickness after 4 weeks of LED exposure 2h every day or LED illuminated environment. This

study provides important data regarding the efficacy and safety of LED light in family illumination. It is impossible to consider these degenerative changes are related unavoidably part of their mechanism of action or an avoidable toxic effect.

## Light Spectrum

**"Nature, Extent and Ecological Implications of Night-Time Light From Road Vehicles,"** Kevin J. Gaston and Lauren A. Holt, *Journal of Applied Ecology*, Vol. 55, No. 5, pages 2296-2307, September 2018.
https://besjournals.onlinelibrary.wiley.com/doi/10.1111/1365-2664.13157
*From the abstract*:

1. The erosion of night-time by the introduction of artificial lighting constitutes a profound pressure on the natural environment. It has altered what had for millennia been reliable signals from natural light cycles used for regulating a host of biological processes, with impacts ranging from changes in gene expression to ecosystem processes.
2. Studies of these impacts have focused almost exclusively on those resulting from stationary sources of light emissions, and particularly streetlights. However, mobile sources, especially road vehicle headlights, contribute substantial additional emissions.
3. The ecological impacts of light emissions from vehicle headlights are likely to be especially high because these are (1) focused so as to light roadsides at higher intensities than commonly experienced from other sources, and well above activation thresholds for many biological processes; (2) projected largely in a horizontal plane and thus can carry over long distances; (3) introduced into much larger areas of the landscape than experience street lighting; (4) typically broad "white" spectrum, which substantially overlaps the action spectra of many biological processes and (5) often experienced at roadsides as series of pulses of light (produced by passage of vehicles), a dynamic known to have major biological impacts.
4. The ecological impacts of road vehicle headlights will markedly increase with projected global growth in numbers of vehicles and the road network, increasing the local severity of emissions (because vehicle numbers are increasing faster than growth in the road network) and introducing emissions into areas from which they were previously absent. The effects will be further exacerbated by technological developments that are increasing the intensity of headlight emissions and the amounts of blue light in emission spectra.
5. *Synthesis and applications*. Emissions from vehicle headlights need to be considered as a major, and growing, source of ecological impacts of artificial night-time lighting. It will be a significant challenge to minimise these impacts whilst balancing drivers' needs at night and avoiding risk and discomfort for other road users. Nonetheless, there is potential to identify solutions to these conflicts, both through the design of headlights and that of roads.

**"Rapid Assessment of Lamp Spectrum to Quantify Ecological Effects of Light at Night,"** Travis Longcore, Airam Rodríguez, Blair Witherington, Jay F. Penniman, Lorna Herf and Michael Herf, *Journal of Experimental Zoology Part A: Ecological and Integrative Physiology*, June 2018 (epublication ahead of print).
Citation at https://doi.org/10.1002/jez.2184
*From the abstract*: For many decades, the spectral composition of lighting was determined by the type of lamp, which also influenced potential effects of outdoor lights on species and

ecosystems. Light-emitting diode (LED) lamps have dramatically increased the range of spectral profiles of light that is economically viable for outdoor lighting. Because of the array of choices, it is necessary to develop methods to predict the effects of different spectral profiles without conducting field studies, especially because older lighting systems are being replaced rapidly. We describe an approach to predict responses of exemplar organisms and groups to lamps of different spectral output by calculating an index based on action spectra from behavioral or visual characteristics of organisms and lamp spectral irradiance. We calculate relative response indices for a range of lamp types and light sources and develop an index that identifies lamps that minimize predicted effects as measured by ecological, physiological, and astronomical indices. Using these assessment metrics, filtered yellow-green and amber LEDs are predicted to have lower effects on wildlife than high pressure sodium lamps, while blue-rich lighting (e.g., K ≥ 2200) would have greater effects. The approach can be updated with new information about behavioral or visual responses of organisms and used to test new lighting products based on spectrum. Together with control of intensity, direction, and duration, the approach can be used to predict and then minimize the adverse effects of lighting and can be tailored to individual species or taxonomic groups.

*Related Resources*:

**Rapid Assessment of Lamp Spectrum to Quantify Ecological Effects of Light at Night**, Travis Longcore, Airam Rodríguez, Blair Witherington, Jay F. Penniman, Lorna Herf and Michael Herf, 2018.
https://fluxometer.com/ecological/
This web site provides access to the database described in the June 2018 journal article cited above and the newsletter article cited below.

**"Scientist's New Database Can Help Protect Wildlife From Harmful Hues of LED Lights,"** Gary Polakovic, *USC News*, June 12, 2018.
https://news.usc.edu/144389/usc-scientist-database-reduce-effects-of-led-light-on-animals/
*From the article*: The research is important for wildlife conservation. For example, loggerhead sea turtle hatchlings, an endangered species, leave beach nests at night and follow artificial light inland to danger instead of skittering to the ocean. Similarly, lights attract migrating juvenile salmon, exposing them to predators. Also, global declines in insects have been linked in part to light pollution, Longcore said. The new research will help people choose lighting to reduce wildlife impacts.

The researchers focused on only four groups of creatures, which have been studied for light responses previously. Future studies will incorporate more species worldwide.

A central component of the USC research includes the first publicly available database showing how about two dozen different types of artificial lighting affect wildlife. The matrix is called "Rapid Assessment of Lamp Spectrum to Quantify Ecological Effects of Light at Night." Developers, land-use planners and policymakers can use it to choose lighting that balances the needs of nature and people. Today, regulations to limit light direction or intensity typically don't account for the different hues of LED lights, Longcore said.

"If we don't provide advice and information to decisionmakers, they will go with the cheapest lighting or lighting that serves only one interest and does not balance other interests," Longcore said. "We provide a method to assess the probable consequences of new light sources to keep up with the changing technology and wildlife concerns."

**"Experimental Illumination of Natural Habitat—An Experimental Set-Up to Assess the Direct and Indirect Ecological Consequences of Artificial Light of Different Spectral Composition,"** Kamiel Spoelstra, Roy H. A. van Grunsven, Maurice Donners, Phillip Gienapp, Martinus E. Huigens, Roy Slaterus, Frank Berendse, Marcel E. Visser and Elmar Veenendaal, *Philosophical Transactions of the Royal Society; Series B, Biological Sciences,* Vol. 370, No. 1667, May 2015.
http://rstb.royalsocietypublishing.org/content/royptb/370/1667/20140129.full.pdf
*From the abstract:* Artificial night-time illumination of natural habitats has increased dramatically over the past few decades. Generally, studies that assess the impact of artificial light on various species in the wild make use of existing illumination and are therefore correlative. Moreover, studies mostly focus on short-term consequences at the individual level, rather than long-term consequences at the population and community level—thereby ignoring possible unknown cascading effects in ecosystems. The recent change to LED lighting has opened up the exciting possibility to use light with a custom spectral composition, thereby potentially reducing the negative impact of artificial light. We describe here a large-scale, ecosystem-wide study where we experimentally illuminate forest-edge habitat with different spectral composition, replicated eight times. Monitoring of species is being performed according to rigid protocols, in part using a citizen-science-based approach, and automated where possible. Simultaneously, we specifically look at alterations in behaviour, such as changes in activity, and daily and seasonal timing. In our set-up, we have so far observed that experimental lights facilitate foraging activity of pipistrelle bats, suppress activity of wood mice and have effects on birds at the community level, which vary with spectral composition. Thus far, we have not observed effects on moth populations, but these and many other effects may surface only after a longer period of time.

**"Artificial Light Pollution: Are Shifting Spectral Signatures Changing the Balance of Species Interactions?"** Thomas W. Davies, Jonathan Bennie, Richard Inger, Natalie Hempel De Ibarra and Kevin J. Gaston, *Global Change Biology,* Vol. 19, No. 5, pages 1417-1423, February 2013.
https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcb.12166
*From the abstract:* Technological developments in municipal lighting are altering the spectral characteristics of artificially lit habitats. Little is yet known of the biological consequences of such changes, although a variety of animal behaviours are dependent on detecting the spectral signature of light reflected from objects. Using previously published wavelengths of peak visual pigment absorbance, we compared how four alternative street lamp technologies affect the visual abilities of 213 species of arachnid, insect, bird, reptile and mammal by producing different wavelength ranges of light to which they are visually sensitive. The proportion of the visually detectable region of the light spectrum emitted by each lamp was compared to provide an indication of how different technologies are likely to facilitate visually guided behaviours such as detecting objects in the environment. Compared to narrow spectrum lamps, broad spectrum technologies enable animals to detect objects that reflect light over more of the spectrum to which they are sensitive and, importantly, create greater disparities in this ability between major taxonomic groups. The introduction of broad spectrum street lamps could therefore alter the balance of species interactions in the artificially lit environment.

**"Limiting the Impact of Light Pollution on Human Health, Environment and Stellar Visibility,"** Fabio Falchi, Pierantonio Cinzano, Christopher D. Elvidge, David M. Keith and Abraham Haim, *Journal of Environmental Management*, Vol. 92, No. 10, pages 2714-2722, October 2011.
Citation at http://www.sciencedirect.com/science/article/pii/S030147971100226X
*From the abstract*: Light pollution is one of the most rapidly increasing types of environmental degradation. Its levels have been growing exponentially over the natural nocturnal lighting levels

provided by starlight and moonlight. To limit this pollution several effective practices have been defined: the use of shielding on lighting fixture to prevent direct upward light, particularly at low angles above the horizon; no over lighting, i.e., avoid using higher lighting levels than strictly needed for the task, constraining illumination to the area where it is needed and the time it will be used. Nevertheless, even after the best control of the light distribution is reached and when the proper quantity of light is used, some upward light emission remains, due to reflections from the lit surfaces and atmospheric scatter. The environmental impact of this "residual light pollution" cannot be neglected and should be limited too. Here we propose a new way to limit the effects of this residual light pollution on wildlife, human health and stellar visibility. We performed analysis of the spectra of common types of lamps for external use, including the new LEDs. We evaluated their emissions relative to the spectral response functions of human eye photoreceptors, in the photopic, scotopic and the 'meltopic' melatonin suppressing bands. We found that the amount of pollution is strongly dependent on the spectral characteristics of the lamps, with the more environmentally friendly lamps being low pressure sodium, followed by high pressure sodium. Most polluting are the lamps with a strong blue emission, like Metal Halide and white LEDs. Migration from the now widely used sodium lamps to white lamps (MH and LEDs) would produce an increase of pollution in the scotopic and melatonin suppression bands of more than five times the present levels, supposing the same photopic installed flux. This increase will exacerbate known and possible unknown effects of light pollution on human health, environment and on visual perception of the Universe by humans. We present quantitative criteria to evaluate the lamps based on their spectral emissions and we suggest regulatory limits for future lighting.

## Lighting Alternatives

**"New Framework of Sustainable Indicators for Outdoor LED (Light Emitting Diodes) Lighting and SSL (Solid State Lighting),"** Annika K. Jägerbrand, *Sustainability*, Vol. 7, No. 1, pages 1028-1063, January 2015.
http://www.mdpi.com/2071-1050/7/1/1028/htm
*From the abstract:* Light emitting diodes (LEDs) and SSL (solid state lighting) are relatively new light sources, but are already widely applied for outdoor lighting. Despite this, there is little available information allowing planners and designers to evaluate and weigh different sustainability aspects of LED/SSL lighting when making decisions. Based on a literature review, this paper proposes a framework of sustainability indicators and/or measures that can be used for a general evaluation or to highlight certain objectives or aspects of special interest when choosing LED/SSL lighting. LED/SSL lighting is reviewed from a conventional sustainable development perspective, i.e., covering the three dimensions, including ecological, economic and social sustainability. The new framework of sustainable indicators allow prioritization when choosing LED/SSL products and can thereby help ensure that short-term decisions on LED/SSL lighting systems are in line with long-term sustainability goals established in society. The new framework can also be a beneficial tool for planners, decision-makers, developers and lighting designers, or for consumers wishing to use LED/SSL lighting in a sustainable manner. Moreover, since some aspects of LED/SSL lighting have not yet been thoroughly studied or developed, some possible future indicators are suggested.

**Outdoor Lighting Retrofits: A Guide for the National Park Service and Other Federal Agencies**, National Park Service and the California Lighting Technology Center, University of California, Davis, July 2014.
http://cltc.ucdavis.edu/sites/default/files/files/publication/nps-outdoor-lighting-retrofits-guide-july2014.pdf
*From page 5 of the PDF*:

> This guide provides an overview of outdoor lighting best practices as well as information on lighting technologies that can optimize energy, cost and maintenance savings. It offers guidance for evaluating light sources, performing a lighting audit, and pairing lamps with lighting controls. In many cases, following best practices allows facilities to exceed federal standards for outdoor lighting energy efficiency.

The guide also briefly addresses the "measures [that] can be taken to minimize the impact of nighttime lighting on any wildlife in the surrounding ecosystem."

**"Reducing the Ecological Consequences of Night-Time Light Pollution: Options and Developments,"** Kevin J. Gaston, Thomas W. Davies, Jonathan Bennie and John Hopkins, *Journal of Applied Ecology*, Vol. 49, No. 6, pages 1256-1266, December 2012.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3546378/
*From the abstract:*

1. Much concern has been expressed about the ecological consequences of night-time light pollution. This concern is most often focused on the encroachment of artificial light into previously unlit areas of the night-time environment, but changes in the spectral composition, duration and spatial pattern of light are also recognized as having ecological effects.
2. Here, we examine the potential consequences for organisms of five management options to reduce night-time light pollution. These are to (i) prevent areas from being artificially lit; (ii) limit the duration of lighting; (iii) reduce the 'trespass' of lighting into areas that are not intended to be lit (including the night sky); (iv) change the intensity of lighting; and (v) change the spectral composition of lighting.
3. Maintaining and increasing natural unlit areas is likely to be the most effective option for reducing the ecological effects of lighting. However, this will often conflict with other social and economic objectives. Decreasing the duration of lighting will reduce energy costs and carbon emissions, but is unlikely to alleviate many impacts on nocturnal and crepuscular animals, as peak times of demand for lighting frequently coincide with those in the activities of these species. Reducing the trespass of lighting will maintain heterogeneity even in otherwise well-lit areas, providing dark refuges that mobile animals can exploit. Decreasing the intensity of lighting will reduce energy consumption and limit both skyglow and the area impacted by high-intensity direct light. Shifts towards 'whiter' light are likely to increase the potential range of environmental impacts as light is emitted across a broader range of wavelengths.
4. Synthesis and applications. The artificial lightscape will change considerably over coming decades with the drive for more cost-effective low-carbon street lighting solutions and growth in the artificially lit area. Developing lighting strategies that minimize adverse ecological impacts while balancing the often conflicting requirements of light for human utility, comfort and safety, aesthetic concerns, energy consumption and carbon emission reduction constitute significant future challenges. However, as both lighting technology and understanding of its ecological effects develop, there is potential to identify adaptive solutions that resolve these conflicts.

## Measuring Artificial Light

**"Quantifying Urban Light Pollution: A Comparison Between Field Measurements and EROS-B Imagery,"** Yali Katz and Noam Levin, *Remote Sensing of Environment*, Volume 177, pages 65-77, May 2016.
Citation at https://www.sciencedirect.com/science/article/pii/S0034425716300451
*From the abstract:* Artificial night lighting and its negative consequences are of interest in the fields of Astronomy, Human Geography, Ecology and Human Health. The majority of studies to date focused on the impacts light pollution has on our ability to view the night sky, as well as on biodiversity, ecosystems and humans. However, in recent years, with the emergence of new high spatial resolution sensors, providing detailed evaluation of night lights at the local level, more attention has been given for estimating and quantifying artificial light within cities. In this study, we evaluate urban night lights within the city of Jerusalem by combining data from two remote sensing tools: ground measurements using Sky Quality Meter (SQM) devices and space-borne measurements using EROS-B night light imagery. In addition, we examined the use of the SQM for evaluating artificial light in different view directions: upwards, downwards and horizontally. Differences in night lights were found between the three SQM view directions, with the brightest values measured in the horizontal direction (8.7–18.9 $mag_{SQM}$ $arcsec^{-2}$, and darkest values in the downwards direction (11.2–19.5 $mag_{SQM}$ $arcsec^{-2}$). The downwards SQM measurements were influenced by surface albedo, the horizontal direction was the most exposed to direct lights from buildings and cars, while in most locations the upwards direction represented skyglow. Using quantile regression we found strong correlations between the SQM and EROS-B brightness values. Statistically significant correlations ($R^2$ = 0.53) were found between the upwards and downwards devices to the EROS-B in the 0.95 quantile, as well as between the horizontal device to the EROS-B in the 0.90 quantile ($R^2$ = 0.44). In addition to local and external light sources, bright areas on the EROS-B image were associated with areas of low vegetation cover and high albedo. This study provides evidence for the correspondence between field and space-borne measurements of artificial lights and emphasizes the need for better understanding of light pollution at the local level and for taking into account of the three-dimensional nature of light pollution.

# Contacts

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# Appendix A: Survey Questions

Two surveys, presented below, were conducted for this project:

- An initial nine-question survey sought information from a broad range of potential respondents:
    - State department of transportation (DOT) members of the AASHTO Committee on Environment and Sustainability.
    - Participants in the Wildlife, Fisheries and Transportation Listserv managed by the Center for Transportation and the Environment at North Carolina State University. Listserv managers note that the list "is intended to facilitate discussion among transportation and environmental professionals about emerging issues and best practices that improve the way ecological issues are addressed in surface transportation."
- A follow-up survey was distributed to selected respondents to gather additional information about agency practices with regard to LED lighting.

## First Survey

### Assessing the Impacts of LED Lighting to Wildlife

1. Has your agency identified impacts, or the potential for impacts (direct, indirect or cumulative), to wildlife from the use of LED lighting?
    - No.
    - Yes.
2. Has your agency completed research—published or unpublished—examining effects of LED lighting and its impacts to wildlife?
    - No.
    - Yes. Please describe this research and provide a link to the research report or send any files not available online to chris.kline@ctcandassociates.com.

### Lighting Alternatives and Modifications

3. Has your agency identified commercial wildlife-friendly LED lighting that has been approved for use?
    - No.
    - Yes. Please describe this lighting and provide product details, including plans and drawings, if available. Send any files not available online to chris.kline@ctcandassociates.com.
4. Aside from LED lighting solutions, has your agency identified a cost-effective, energy-efficient lighting alternative that avoids or minimizes impacts to wildlife?
    - No.
    - Yes. Please describe the lighting alternative(s), including the vendor and product details.

### Agency Use of LED Lighting in Sensitive Wildlife Habitat

5. Does your agency use LED lighting in areas where protected wildlife species habitat is present?
    - No.
    - Yes.
6. Has your agency adopted specifications for LED or other lighting for use in sensitive species areas?
    - No.
    - Yes. Please provide a link to these specifications or send any files not available online to chris.kline@ctcandassociates.com.

### Feedback Related to Wildlife-Friendly LED Lighting

7. Has your agency identified any conflicts between competing stakeholders as a result of implementing wildlife-friendly LED lighting?
    - No.
    - Yes. Please describe your agency's response to these conflicts.

### Wrap-Up

8. Please provide links to any other documentation associated with your agency's use of wildlife-friendly LED or other lighting that you have not already provided. Send any files not available online to chris.kline@ctcandassociates.com.
9. Please use this space to provide any comments or additional information about your previous responses.

## Follow-Up Survey

### Assessing the Impacts of LED Lighting to Wildlife

1. Please describe the impacts or potential for impacts to wildlife your agency has identified in each topic area below.

    Location:

    Species affected:

    Lighting type used:

    Metrics used to quantify impacts or effects:

    Extent of impact area (for example, feet from light source):
2. Has your agency completed any environmental review or consultation(s), such as with the U.S. Fish and Wildlife Service, on lighting projects?
    - No.
    - Yes. Please summarize the results of these consultations and include any discussions of indirect effects and resulting avoidance and minimization measures.

**Lighting Alternatives**

3. If your agency has attempted to modify commercial LED or other lighting installations to minimize impacts to wildlife, please describe below each modification technique your agency has used.
    - Lighting filter.
    - Shielding.
    - Selecting luminaires with low backlight, uplight and glare (BUG) ratings.
    - Adjustments based on presence of vehicles on the roadway.
    - Adjustments based on ambient nighttime light.
    - Adjustments based on timers.
    - Other technique 1 (please describe).
    - Other technique 2 (please describe).
    - Other technique 3 (please describe).
4. If your agency has attempted to modify commercial LED or other lighting installations to minimize impacts to wildlife, please describe the modifications' success by rating all the techniques below that apply using the rating scale of 1 = not at all successful to 5 = extremely successful.
    - Lighting filter.
    - Shielding.
    - Selecting luminaires with low backlight, uplight and glare (BUG) ratings.
    - Adjustments based on presence of vehicles on the roadway.
    - Adjustments based on ambient nighttime light.
    - Adjustments based on timers.
    - Other technique 1 (as described in Question 3).
    - Other technique 2 (as described in Question 3).
    - Other technique 3 (as described in Question 3).
5. Has your agency employed any nonlighting measures that meet safety requirements and avoid or minimize impacts to wildlife?
    - No.
    - Yes. Please describe these nonlighting measures.

**Feedback Related to Wildlife-Friendly LED Lighting**

6. Has your agency received public comments in response to implementation of wildlife-friendly LED lighting?
    - No.
    - Yes. Please summarize these public comments.

**Wrap-Up**

7. Please use this space to provide any comments or additional information about your previous responses.

Appendix C – Avian Collision Risk Assessment

October 18, 2022

Marc Huffman
Lincoln Property Company
915 Wilshire Boulevard, Suite 2050
Los Angeles, CA 90017

**Subject:** 777 Airport Boulevard – Updated Avian Collision Risk Assessment (HTH #4583-01)

Dear Marc Huffman:

Per your request, H. T. Harvey & Associates has assessed avian collision risk and lighting impacts on birds in support of the proposed 777 Airport Boulevard Project located southeast of San Francisco International Airport and north of the Burlingame Lagoon in the Bayfront neighborhood of Burlingame, California. It is our understanding that the project will demolish the existing improvements on the site and construct a 13-story, 194-foot tall building with 403,425 square feet of office space and six levels of parking. We further understand that you are requesting our assistance to assess the potential for avian collisions to occur with the proposed building for purposes of California Environmental Quality Act (CEQA) review of the project. This report summarizes our analysis of bird collision and lighting hazards associated with the project and describes measures necessary, in our opinion, to mitigate potentially significant impacts to less-than-significant levels under CEQA.

The project site is aligned northeast-southwest, but compass directions as they refer to the project site throughout this report are referenced consistently with the project's plans, which refer to *northwest* as *north*, *northeast* as *east*, *southwest* as *west*, and *southeast* as *south*. Off-site features are referenced according to actual compass directions.

## Methods

This assessment was prepared by H. T. Harvey & Associates wildlife ecologists/ornithologists Steve Rottenborn, Ph.D., and me. Briefly, our qualifications are as follows (résumés attached):

- S. Rottenborn has a Ph.D. in biological sciences from Stanford University, where his doctoral dissertation focused on the effects of urbanization on riparian bird communities in the South San Francisco Bay area. He has been an active birder for more than 35 years and has conducted or assisted with research on birds since 1990. He has served for 9 years as an elected member of the California Bird Records Committee

(including 3 years as chair) and for 13 years as a Regional Editor for the Northern California region of the journal North American Birds. He is a member of the Scientific Advisory Board for the San Francisco Bay Bird Observatory, the Technical Advisory Committee for the South Bay Salt Ponds Restoration Project, and the Board of Directors of the Western Field Ornithologists.

- I am a wildlife ecologist with a B.S. in Ecology from the University of California, San Diego and an M.S. in Fish and Wildlife Management from Montana State University, where my Master's thesis focused on factors affecting the nest survival of yellow warblers (*Setophaga petechia*), dusky flycatchers (*Empidonax oberholseri*), and warbling vireos (*Vireo gilvus*). Trained as an ornithologist, I specialize in the nesting ecology of passerine birds, with a broad range of avian field experience from across the United States. I am an avid birder, and I volunteered as a bird bander for the San Francisco Bay Bird Observatory, where I banded, sexed, and aged resident and migrant passerine species from 2010–2020. I have spent hundreds of hours in the field conducting nesting bird surveys for H. T. Harvey & Associates' projects over the past 14 years, and have found hundreds of passerine nests as well as many nests of raptors.

In addition, H. T. Harvey & Associates Ecologist Jane Lien, B.S., conducted a reconnaissance-level survey of the project site on November 23, 2021 to characterize potential bird use of the site and immediately surrounding areas. Steve Rottenborn is also familiar with the project site from his prior work preparing a peer review of a biological resources report and assessment of avian collision risk for the TopGolf Burlingame Project, which is directly west of the proposed project.

Although the subject of bird-friendly design is relatively new to the West Coast, we have performed avian collision risk assessments and identified measures to reduce collision risk for a number of projects in more than a dozen Bay Area municipalities.

## Assessment of Bird Use

### *Existing Conditions*

The project site is located in the Bayfront neighborhood of Burlingame, which lies southeast of San Francisco International Airport between U.S. Route 101 to the south and the San Francisco Bay to the north (Figure 1). The site is bordered by the tidal waters of Burlingame Lagoon to the south, Anza Boulevard to the northwest, Airport Boulevard to the northeast, and a parking lot to the east. The open waters of the San Francisco Bay lie approximately 650 feet to the north, and Anza Lagoon is located approximately 800 feet to the northeast. The site is surrounded by commercial office buildings, hotels, a large parking lot, and several large sports fields to the west.


**Figure 1. The project site (delineated in yellow) and its immediate surroundings to the north, east, and west are dominated by commercial uses. The tidal waters of Burlingame Lagoon lie directly to the south, and the San Francisco Bay and Anza Lagoon lie 650 feet to the north and 800 feet to the northeast, respectively.**

Habitat conditions and bird occurrence in the immediate vicinity of the project site (i.e., on the site and on immediately adjacent lands) are typical of much of the urbanized San Francisco Bay Area. The 3.1-acre project site is currently occupied by an existing hotel and restaurant building surrounded by a paved parking lot. The margins of the parking lot are lined with mature landscape trees and small areas of nonnative landscape vegetation including low shrubs, herbaceous plants, and turf (Photos 1 and 2). Mature trees on the site are nonnative and primarily consist of nonnative red ironbark (*Eucalyptus sideroxylon*), with a smaller number of blackwood (*Acacia melanoxylon*) scattered amongst them. Smaller trees and shrubs are sparsely distributed, and include nonnative cotoneaster (*Cotoneaster* sp.), wattle (*Acacia* sp.), sweet pittosporum (*Pittosporum undulatum*), and crepe myrtle (*Lagerstroemia* sp.). A hedge of nonnative Italian buckthorn (*Rhamnus alaternus*) is located along the eastern margin of the parking lot, and also creates a screen along the fence surrounding the hotel's swimming pool.

**Photos 1 and 2. The site consists of a hotel surrounded by a paved parking lot with mature, nonnative landscape trees and scattered small trees, shrubs, and turf.**

The site and most of the rest of the Bayfront neighborhood of Burlingame provide low-quality habitat for most native birds found in the region due to the limited extent of vegetation, the lack of any native vegetation, the absence of well-layered vegetation (e.g., with ground cover, shrub, and canopy tree layers in the same areas), the small size of the vegetated habitat patches, and the amount of human disturbance by vehicular traffic and occupants of buildings on and/or adjacent to the project site, which is developed as a hotel. Nevertheless, these areas support a suite of common, urban-adapted bird species characteristic of such urban areas that are expected to occur on the site regularly. These include the native American robin (*Turdus migratorius*), Brewer's blackbird (*Euphagus cyanocephalus*), bushtit (*Psaltriparus minimus*), house finch (*Haemorhous mexicanus*), American crow (*Corvus brachyrhynchos*), and Anna's hummingbird (*Calypte anna*), as well as the nonnative European starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*). All of these birds are year-round residents that can potentially nest on or in the immediate vicinity of the project site. A number of other species, primarily migrants or winter visitors (i.e., nonbreeders), occur occasionally on and adjacent to the site as well, including the cedar waxwing (*Bombycilla cedrorum*), white-crowned sparrow (*Zonotrichia leucophrys*), golden-crowned sparrow (*Zonotrichia atricapilla*), and yellow-rumped warbler (*Setophaga coronata*). For example, low numbers of migrants are expected to forage in the ornamental vegetation on the site. However, no bird species are expected to occur on the site in large numbers, and all of the species expected to occur regularly are regionally abundant species. No special-status birds (i.e., species of conservation concern) are expected to nest or otherwise occur regularly on the site.

The Burlingame Lagoon, located directly adjacent to the southern boundary of the site, is a tidally influenced, linear lagoon with a shoreline armored by imported rock and riprap (Photo 3). During high tides, the lagoon provides open-water foraging habitat for waterbirds including the double-crested cormorant (*Nannopterum auritum*), mallard (*Anas platyrhynchos*), elegant tern (*Thalasseus elegans*), common goldeneye (*Bucephala clangula*), greater scaup (*Aythaya marila*), lesser scaup (*Aythya affinis*), bufflehead (*Bucephala albeola*), green-winged teal (*Anas crecca*), American wigeon (*Mareca americana*), ruddy duck (*Oxyura jamaicensis*), northern shoveler (*Spatula clypeata*), and American coot (*Fulica americana*), which occur in flocks of varying size during winter and migration. During low tide, the lagoon provides foraging habitat for small numbers of shorebirds, including the western sandpiper (*Calidris mauri*), dunlin (*Calidris alpina*), semipalmated plover (*Calidris pusilla*), least sandpiper (*Calidris minutilla*),

short-billed dowitcher (*Limnodromus griseus*), black-necked stilt (*Himantopus mexicanus*), and long-billed dowitcher (*Limnodromus scolopaceus*). The section of the lagoon on the opposite side of Anza Avenue southwest of the site supports tidal marsh habitat, with a more naturalized shoreline and apparent tidal channels surrounded by emergent marsh vegetation (Photo 4). This area supports many of the same bird species noted above, but in greater diversity and abundance compared to the section of the lagoon located immediately adjacent to the project site due to the higher-quality cover and foraging resources provided by the more complex physical and biological structure of the tidal marsh. The Alameda song sparrow (*Melospiza melodia pusillula*), a California species of special concern that is closely associated with salt marsh habitats around the San Francisco Bay, nests and forages in the marsh vegetation along this tidal marsh shoreline year-round.

**Photo 3. Burlingame Lagoon, south of and adjacent to the site, is channelized with an armored shoreline.**

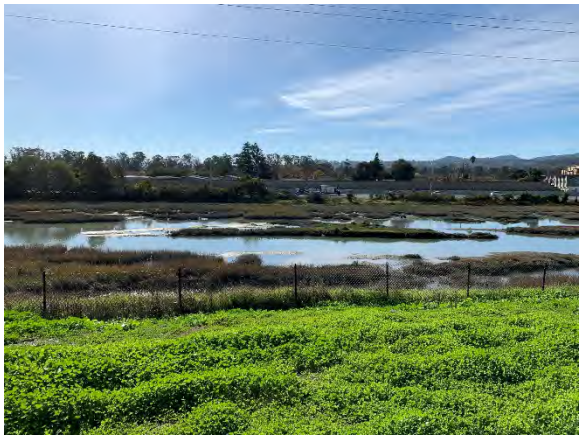

**Photo 4. North of Anza Boulevard, Burlingame Lagoon is more naturalized, with tidal channels and emergent marsh vegetation.**

The open waters of the San Francisco Bay, approximately 650 feet north of the project site, provide open-water and shoreline foraging habitat for the species of waterbirds and shorebirds listed above. In general, higher numbers of these birds are expected to occur within the open waters of the San Francisco Bay (for waterbirds) and along the Bay shoreline (for shorebirds) compared to Burlingame Lagoon due to the more extensive areas of foraging habitat present. In addition, Anza Lagoon, located approximately 800 feet northeast of the project site, supports similar open water and shoreline foraging habitats, and hosts similar species of birds in smaller numbers. Many of these birds will fly over the proposed project site while moving between the San Francisco Bay and Anza Lagoon to the north and northeast and Burlingame Lagoon to the south.

Due to its location along the edge of the San Francisco Bay, Burlingame Lagoon supports relatively high numbers and species of birds compared to areas located farther inland in Burlingame (Figure 2). Based on observations by birders over the years, approximately 136 different species of birds have been encountered in Burlingame Lagoon, including year-round resident, migrant, and wintering landbirds (associated with upland areas), shorebirds (associated with the shoreline), and waterbirds (associated with open water habitat) (Cornell Lab of Ornithology 2022). Ebird records suggest that some species of shorebirds and waterbirds can occur in these areas in large numbers (i.e., 100–200 individuals), but the majority of these species occur in smaller flocks.

A number of migrant bird species will remain in this area for days to weeks to rest and forage. As a result, even the limited amount of vegetation within and along the project site is expected to attract migrants in greater abundance than areas farther inland in urban areas of Burlingame. Resident birds that are present in the vicinity year-round are similarly attracted to the open habitats at Burlingame Lagoon in relatively large numbers for foraging opportunities (Cornell Lab of Ornithology 2022).

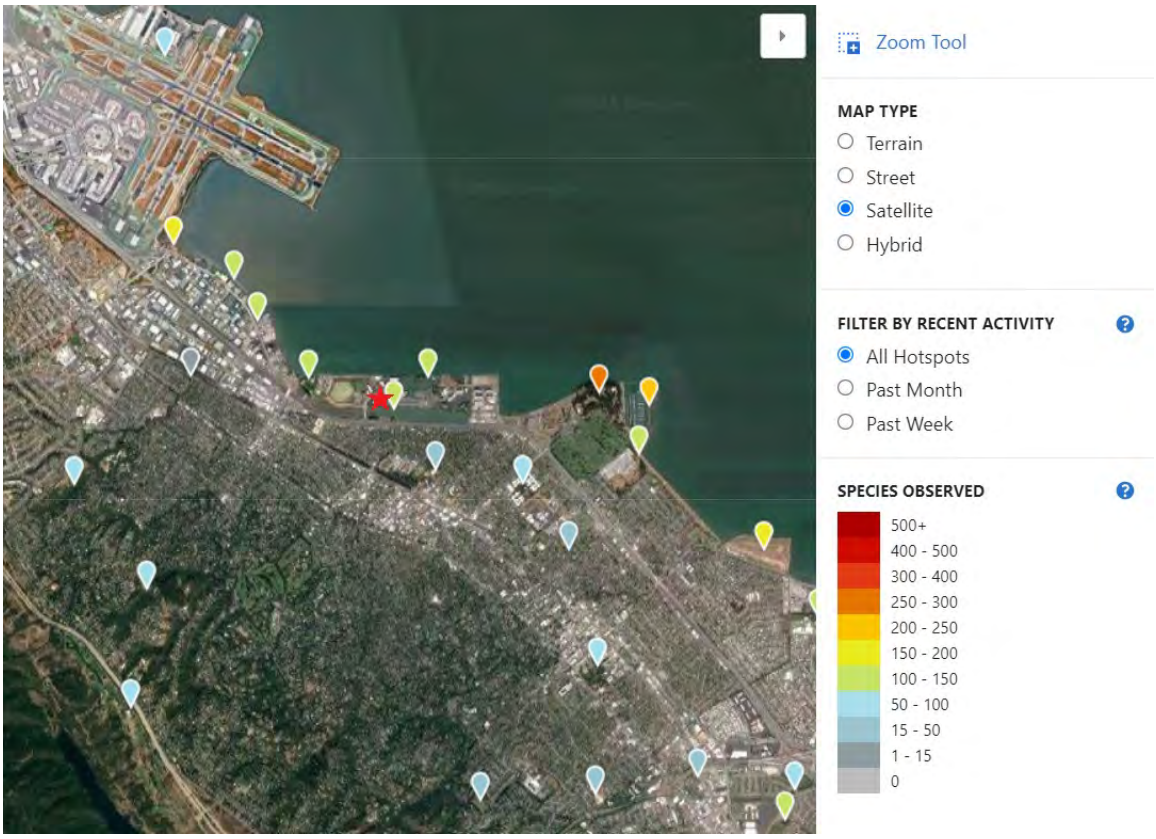


**Figure 2. Map of eBird Hotspots in the project vicinity. The project site is indicated by a red star. Coyote Point is the hotspot with the orange marker (250–300 species observed).**

Many species of warblers, vireos, flycatchers, swallows, and other landbirds occur along the edge of the Bay in the project vicinity during migration. Coyote Point, located approximately 1.5 miles east of the site, supports dense stands of mature trees including many eucalyptus (*Eucalyptus* sp.) trees, which provide foraging habitat for these migrants. Due to the numerous large trees present here and its location along the edge of the San Francisco Bay, Coyote Point attracts very large numbers of landbirds during migration compared to other locations in the vicinity (Figure 2). Examples of high counts of individual bird species seen at Coyote Point include up to 160 violet-green swallows (*Tachycineta thalassina*), 315 cedar waxwings, 150 mourning doves (*Zenaida macroura*), and 156 white-crowned sparrows (Cornell Lab of Ornithology 2022). Even higher counts exist that are not in the eBird database, but that have been reported to the Peninsula-Birding list-serve (https://groups.io/g/peninsula-birding); examples include counts of 234 violet-green swallows and 2,065 cedar waxwings on May 12, 2019. Thus, despite the limited extent of vegetation present on the project site, given the site's landscape position relative to important bird habitats such as the San Francisco Bay, Burlingame Lagoon,

and Coyote Point, relatively high numbers of migrant birds are expected to occur on the site, and/or fly past the site, compared to similar developed areas located farther inland in Burlingame.

### *Proposed Site Conditions*

The number of birds that use the site may decrease initially following project construction due to removal of 125 trees on and immediately adjacent to the site. However, over the long term, bird abundance is expected to increase due to the replacement of these primarily nonnative landscape trees with a mix of 106 native and nonnative trees, shrubs, and forbs. The proposed landscape vegetation is divided into four planting palettes: the Shoreline Garden, Stormwater Garden, Ornamental Garden, and Streetscape Planting. The Shoreline and Stormwater Gardens will consist primarily of native plant species, while the Ornamental Garden and Streetscape Planting will consist primarily of nonnative landscape plant species. Trees proposed on the project site include native coast live oaks (*Quercus agrifolia*), a species notable for providing high-quality resources for native birds, which will be planted in the westernmost portion of the site along Anza Boulevard, the San Francisco Bay Trail, and the Sloped Garden area. Native toyon (*Heteromeles arbutifolia*) and coffeeberry (*Rhamnus californica*), which often grow as shrubs but are identified as 'trees' on the plans, will be planted throughout the Shoreline Garden areas including adjacent to the northwest corner of the building and along the site's southern boundary. Locally nonnative Monterey cypress (*Hesperocyparis macrocarpa*) and nonnative London plane trees (*Platanus* x *acerifolia*), sawleaf zelkova (*Zelkova serrata*), fern pines (*Afrocarpus gracilior*), and Marina madrones (*Arbutus marina*) will be planted in other areas. Shrubs and herbaceous landscape plants in the Shoreline Garden areas include native coyote brush (*Baccharis pilularis*), California buckwheat (*Eriogonum fasciculatum*), California fuchsia (*Epilobium canum*), monkey flower (*Mimulus* sp.), and salvia (*Salvia* sp.), as well as nonnative atlas fescue (*Festuca mairei*). The Sloped Garden area will incorporate primarily native plants including deer grass (*Muhlenbergia rigens*), manzanita, California sagebrush (*Artemisia californica*), gray rush (*Juncus patens*), coffeeberry (*Rhamnus californica*), and narrow leaf milkweed (*Asclepias fascicularis*). The Ornamental Garden will be composed of primarily nonnative plants, including harmony kangaroo paw (A*nigozanthos* sp.), flax lily (*Dianella* sp.), Mexican heather (*Cuphea hyssopifolia*), New Zealand iris (*Libertia grandiflora*), grassland sedge (*Carex divulsa*), lomandra (*Lomandra longifolia*), and a cultivar of one native plant, California fuschia. Streetscape Planting areas will incorporate nonnative fortnight lily (*Dietes grandiflora*), Mexican bush sage (*Salvia leucantha*), coast rosemary (*Westringia fruticosa*), and pine muhly (*Muhlenbergia dubia*). An illustrative site plan showing the extent of proposed vegetation on the site is provided as Figure 3.

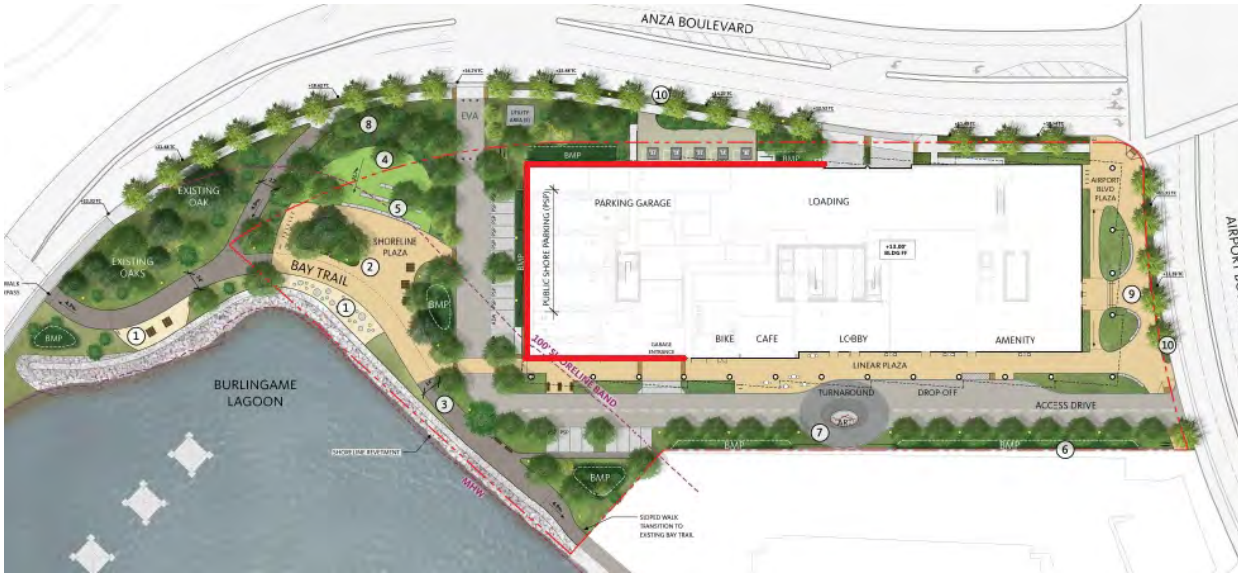


**Figure 3. Illustrative site plan. Areas of heightened collision risk with the lower 60 feet of the building are identified in red.**

Under proposed conditions, the proposed mixed native and nonnative tree and plant species on the site will provide resources for birds such as food (e.g., seeds, fruits, nectar, or foliage that supports insect prey), nesting sites, roosting sites, and cover from predators. The presence of these resources will enhance the ecological value of the site for native resident, migrant, and wintering birds compared to existing conditions, helping to increase these populations of species that tolerate urban areas. Based on the proposed extent of vegetation on the site as well as the native vegetation and trees included in the planting plan (Figure 3), in our opinion this vegetation is expected to attract greater numbers of landbirds to the site, including both resident birds and migrating birds, compared to existing conditions. Migrant landbirds that may be concentrated along the edge of San Francisco Bay are expected to be attracted to vegetated open space areas on the site following landscaping, as these areas will be visible from above as potential resting and foraging opportunities along a densely developed urban shoreline. Thus, a moderate increase in the abundance of resident birds and a larger increase in the abundance of migrating birds is expected as a result of the proposed landscaping. Waterbirds are not expected to be attracted to the site's landscaping or to change in abundance or distribution as a result of the project.

## Assessment of Collision Risk Due to Glazing

Because birds do not necessarily perceive glass as an obstacle (Sheppard and Phillips 2015), windows or other structures that reflect the sky, trees, or other habitat may not be perceived as obstacles, and birds may collide with these structures. Similarly, transparent windows can result in bird collisions when they allow birds to perceive an unobstructed flight route through the glass (such as at corners), and when the combination of transparent glass and interior vegetation results in attempts by birds to fly through glass to reach vegetation. A number of factors play a role in determining the risk of bird collisions with buildings, including the amount and

type of glass used, lighting, properties of the building (e.g., size, design, and orientation), type and location of vegetation around the building, and building location.

As noted above, numerous native, resident birds occur in the project vicinity. Because resident birds are present within an area year-round, they are more familiar with their surroundings and can be less likely to collide with buildings compared with migrant birds (discussed below). However, the numbers of resident birds that collide with buildings can still be relatively high over time. Young birds that are more naïve regarding their surroundings are more likely to collide with glass compared to adult birds. In addition, although adult birds are often more familiar with their surroundings, they still collide with glass with some frequency, especially when they are startled (e.g., by a predator) and have limited time to assess their intended flight path to avoid glazed facades. As a result, a moderate number of resident (i.e., breeding or overwintering) landbirds may collide with the project buildings over time.

Migrant landbirds are also expected to be attracted to the project vicinity during migration periods in the spring and fall, especially along the shoreline where native oaks are currently present and more will be planted, but also along the margins of the parking areas where mature trees will be removed but more will, over time, take their place. When these birds arrive in the site vicinity they are tired from flying (usually at night), they are hungry, and they are less likely to be aware of risks such as glass compared to well-fed, local resident, summering, or wintering birds familiar with their surroundings. As these migrants descend from higher altitudes, they will seek suitable resting and foraging resources in the new landscape vegetation surrounding the buildings. During this reorientation process, migrants will be susceptible to collisions with the buildings if they cannot detect the glass as a solid structure to be avoided. Migrant birds that use structures for roosting and foraging (such as swifts and swallows) will also be vulnerable to collisions if they perceive building interiors as potential habitat and attempt to enter the buildings through glass walls.

Once migrants have descended and decided to settle into vegetation on or adjacent to the project site, they may collide with the glass because they do not detect it as a solid surface and think they can fly through the building. Foggy conditions may exacerbate collision risk, as birds may be even less able to perceive that glass is present in the fog. The highest collision risk would likely occur when inclement weather enters the region on a night of heavy bird migration, when clouds and fog make it difficult for birds to find high-quality stopover sites once they reach ground level.

The extent of glazing on a building and the presence of vegetation opposite the glazing are known to be two of the strongest predictors of avian collision rates (Delb and Delacretaz 2009, Borden *et al.* 2010, Cusa *et al.* 2015, Riding *et al.* 2020). Further, the greatest risk of avian collisions with glazed façades is in the area within 60 feet of the ground, because this is the area in which most bird activity occurs (San Francisco Planning Department 2011). Therefore, we would expect collision risk on the proposed building to be highest within approximately 60 feet of the ground where landscape vegetation or Burlingame Lagoon occurs adjacent to or opposite extensive areas of glass. In addition, because the proposed building is located in a landscape position such that natural areas are present close by on several sides (i.e., the San Francisco Bay to the north, Burlingame

Lagoon to the south, and Anza Lagoon to the northeast), relatively high numbers of birds are expected to traverse the airspace on the project site over time when traveling in between these habitats. Thus, collision risk may also be relatively high with glazed facades on the building's upper levels if this glazing is either transparent such that areas of sky are visible from one side of the building to the other, or reflective such that sky or water is reflected in the glazing.

Several features of the proposed building's architecture would reduce the frequency of avian collisions. In particular, the facades of the building up to 78 feet above grade incorporate extensive areas of perforated metal panels, and we expect birds using habitats on the site and in adjacent areas to be able to perceive these panels as a solid structure from a distance (rather than as reflected sky or vegetation), greatly decreasing the potential for collisions with these portions of the building (Figure 4). In addition, the visible reflectance of all glazing on the building will be 20% or lower. These measures are expected to reduce the potential for bird collisions with the building.

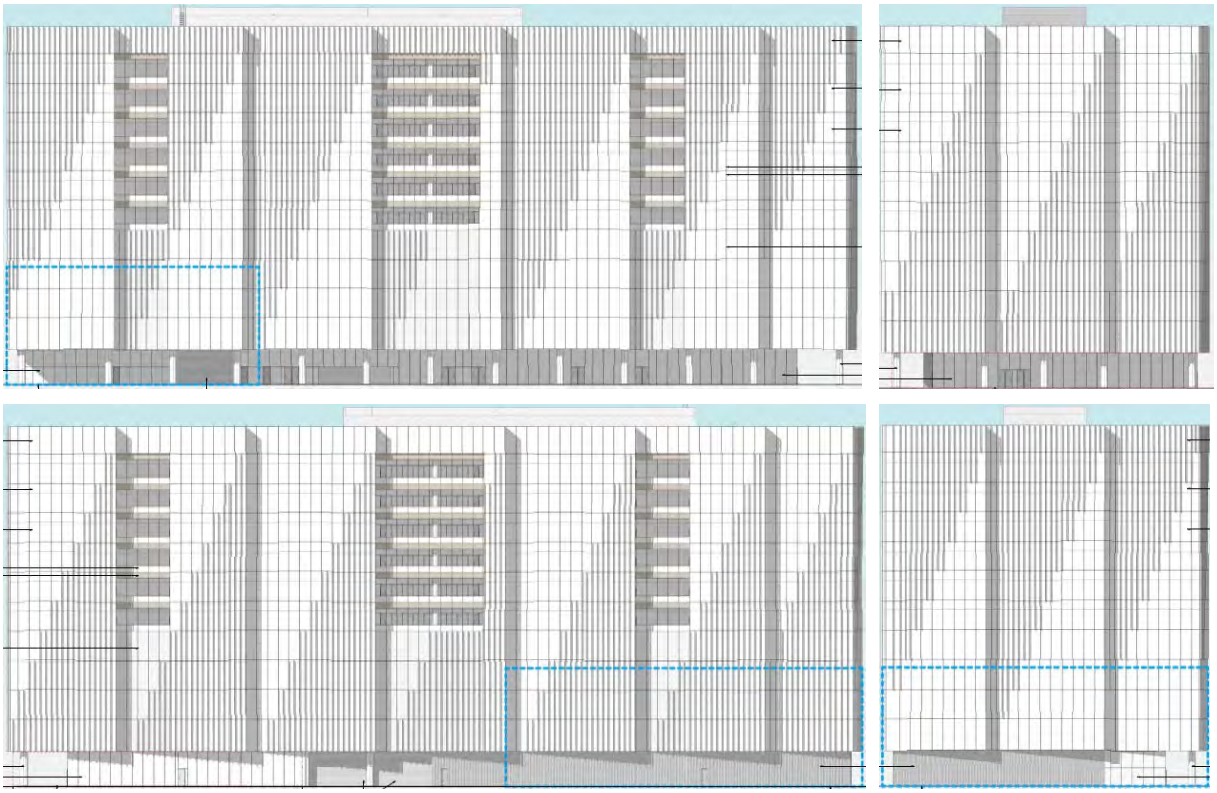

**Figure 4. Views of the south (top left), east (top right), north (bottom left), and west (bottom right) facades of the proposed building. Translucent glazing is shown in blue, spandrel glazing is shown in gray, free-standing glass railings are shown in red, and perforated metal panels are shown in orange.**

Spandrel glazing is proposed on the majority of the building's facades up to 78 feet above grade (Figure 4). Because spandrel glazing is not transparent, it eliminates collision hazards related to transparency (e.g., at glass corners, where a bird can potentially perceive a flight path through the glass to the far side of the corner). However, birds will collide with spandrel due to reflections of sky, water, or vegetation in this glazing. Although

the project's spandrel will have a visible reflectance of 20% or lower, which is consistent with guidance from the City of San Francisco to ensure that glass is not excessively reflective to create a high-risk collision hazard (e.g., due to mirror-like conditions), based on our experience and information from the American Bird Conservancy[1,2], this spandrel is expected to cast reflections and birds are expected to collide with this glazing due to perceived reflections of sky, water, or vegetation in the glass. On the project site, birds are expected to occur in greatest numbers along Burlingame Lagoon and in the adjacent extensive area of landscape vegetation in the western portion of the project site (Figure 3). Birds using these areas are also expected to be drawn within areas of narrower, lower-quality landscape vegetation and trees (i.e., nonnative vegetation and vegetation that is relatively less extensive) that are "connected" to these higher-quality habitat areas, searching for food and cover. Therefore, collision risk is expected to be relatively higher with spandrel glazing located along the building's west façade, the westernmost portion of the north façade (facing landscape vegetation that is connected to the west) and the westernmost portion of the south façade (facing landscape vegetation that is connected to the south and west) (Figure 3). Collision risk is expected to be relatively lower with spandrel glazing on the remaining facades, which faces areas of limited vegetation that are not as connected to higher-quality habitat areas (Figure 3). To reduce the potential for collisions with spandrel glazing on the building, it is our understanding that the project will implement the following measures from the City of San Francisco's *Standards for Bird-Safe Buildings*:

- Glazing on building facades where collision risk is relatively high (as indicated on Figure 3 and pages A2.01–03 of the project's plans) will be treated with a bird-safe glazing treatment such that no more than 10% of the area from 0–60 feet above grade consists of untreated glazing. These façade areas are outlined in blue on Figure 4.
- Bird-safe glazing treatments may include fritting, netting, permanent stencils, frosted glass, exterior screens, physical grids placed on the exterior of glazing or UV patterns visible to birds. Vertical elements of the window patterns should be at least ¼-inch wide at a maximum spacing of 4 inches, and horizontal elements should be at least ⅛-inch wide at a maximum spacing of 2 inches.

In our opinion, these measures will effectively reduce the potential for collisions with spandrel glazing on the building by helping birds perceive the glass railings as solid objects to be avoided, and collision risk with this glazing is expected to be relatively low.

Free-standing glass railings are proposed on balconies on Levels 7–12 of the north and south façades (Figure 4). Where these features are located along potential flight paths that birds may use when traveling to and from landscape vegetation on the site, the risk of bird collisions is higher because birds may not perceive the intervening glass and attempt to fly to vegetation on the far side of the glass. It is unknown whether vegetation will be planted on these balconies; however, if vegetation is included in the design at these locations, birds would be expected to fly to the balconies and potentially collide with any glass railings located along their flight paths. As indicated on pages A2.01–03 of the project's plans, these railings will be treated with a bird-safe

[1] https://abcbirds.org/glass-collisions/threat-factor-rating/
[2] https://abcbirds.org/glass-collisions/learn-more-bird-friendly-legislation/

glazing treatment to reduce the potential for collisions at these locations. Per the recommendations that we provided, this treatment will consist of ¼-inch diameter dots spaced 2 inches apart horizontally and vertically. The density of this frit pattern is greater (and the effectiveness of the bird-safe treatment correspondingly higher) compared to that for the spandrel glazing discussed above due to the relatively higher risk of bird collisions with free-standing glass railings. In our opinion, this will effectively reduce the potential for collisions with free-standing glass railings by helping birds perceive the glass railings as solid objects to be avoided, and collision risk with these railings is expected to be relatively low.

Portions of Level 1 on the south, east, and north facades of the building incorporate translucent glazing (Figure 3). These glazed areas will face portions of the site that support no landscape vegetation or relatively sparse nonnative vegetation, as well as adjacent development and roadways (Figure 3). As a result, relatively low numbers of birds are expected to be attracted to the on-site vegetation located immediately opposite these glazed areas, reducing the potential for collisions with this glazing. Due to these combined factors, it is our opinion that the potential for bird collisions with the translucent glazing on Level 1 of the building will be relatively low.

On Levels 7–12, the building facades are extensively glazed, incorporating both translucent and spandrel glazing (Figure 4). If this glazing appeared transparent such that areas of sky were visible from one side of the building to the other, or cast reflections of sky or water, we would expect a high potential for birds to collide with these façade areas because many birds will encounter these facades in flight as they traverse this airspace when flying between surrounding habitats, as discussed above. However, the project plans indicate that the facades will employ extruded aluminum shadow boxes and mullions, which will help increase the visibility of the building to birds (Figure 4). In addition, the glazing will have a visible reflectance of 20% or lower, and hence would not be highly reflective. It is also our understanding from discussions with the project's architect that the renderings of the building in Figure 4 depict the expected appearance of the constructed building with reasonable accuracy, such that (1) the overall appearance of the building, as well as the tint of the glazing, will be a cool grey color that markedly contrasts with the sky behind it; and (2) the glazing will not be transparent or cast extensive reflections of sky, clouds, and water. Based on this assurance of design intent, it is our opinion that the majority of birds traversing the airspace on the project site would be able to distinguish the building as a solid structure as a distance, and collision risk with Levels 7–12 of the building will be relatively low.

In summary, relatively high numbers of resident and migrant landbirds, shorebirds, and waterbirds occur on and adjacent to the project site. We expect some collisions of these birds with glass facades on the proposed building to occur. However, the project design incorporates extensive opaque metal panels below 78 feet; bird-safe glass at spandrel glazing on the lower 60 feet of the building facing Burlingame Lagoon and areas of landscape vegetation where birds are most likely to occur; bird-safe glass at free-standing glass railings; glazing that is not highly reflective; and shadow boxes, mullions, and tinted glass on Levels 7 and above that helps the building appear as a solid structure to birds in flight. In our opinion, these design features reduce the potential for the relatively high number of birds in the vicinity to collide with the building, and we do not expect the number of collisions to be so high over time as to result in a significant impact under CEQA.

# Assessment of Lighting Impacts

## Project Measures to Minimize Lighting

It is our understanding that a number of general guidelines have been established for the project's lighting plan to address potential impacts related to lighting, as indicated on plan pages A2.01–03. These are as follows:

- Provide minimal nighttime lighting, both indoor and outdoor, as an additional way to make building more bird-friendly,
- provide shielded lighting fixtures,
- provide fixtures with seal of approval of Dark-Sky association or equally performing luminaires,
- no upward lighting shall be provided,
- provide astronomical controls with manual override for night time dimming,
- provide interior shading at perimeter, and
- provide astronomical controls with manual override for operation of interior shading devices.

Specifically, the project will implement the following measures to minimize lighting effects on birds:

- All exterior lighting shall be fully shielded to block illumination from shining outward towards Burlingame Lagoon to the south. All fixtures on the site shall have a BUG rating of U0, and any fixtures located along the site's southern property line shall have a BUG rating of B0, as follows:
    - U0: 0 lumens (90–180 degrees).
    - B0: 110 lumens high (60–80 degrees), 220 lumens mid (30–60 degrees), and 110 lumens low (0–30 degrees)
- Except as indicated in the measure above, fixtures shall comply with lighting zone LZ-2, Moderate Ambient, as recommended by the International Dark-Sky Association (2011) for light commercial business districts and high-density or mixed-use residential districts. The allowed total initial luminaire lumens for the project site is 2.5 lumens per square foot of hardscape, and the BUG rating for individual fixtures shall not exceed B3 or G2, as follows:
    - B3: 2,500 lumens high (60–80 degrees), 5,000 lumens mid (30–60 degrees), 2,500 lumens low (0–30 degrees)
    - G2: 225 lumens (forward/back light 80–90 degrees), 5,000 lumens (forward 60–80 degrees), 1,000 lumens (back light 60–80 degrees asymmetrical fixtures), 5,000 lumens (back light 60–80 degrees quadrilateral symmetrical fixtures)

- Exterior lighting shall be minimized (i.e., total outdoor lighting lumens shall be reduced by at least 30% or extinguished, consistent with recommendations from the International Dark-Sky Association [2011]) from 10:00 p.m. until sunrise, except as needed for safety and City code compliance.
- Interior or exterior blinds shall be programmed to close on all windows from 10:00 p.m. to sunrise in order to block lighting from spilling outward from these windows.

## Overview of Potential Lighting Impacts on Birds

Numerous studies indicate that artificial lighting associated with development can have an impact on both local birds and migrating birds. Below is an overview of typical impacts on birds from artificial lighting, including lighting impacts related to general site lighting conditions and up-lighting.

### Impacts Related to General Site Lighting Conditions

Many animals are sensitive to light cues, which influence their physiology and shape their behaviors, particularly during the breeding season (Ringer 1972, de Molenaar et al. 2006). Artificial light has been used as a means of manipulating breeding behavior and productivity in captive birds for decades (de Molenaar et al. 2006), and has been shown to influence the territorial singing behavior of wild birds (Longcore and Rich 2004, Miller 2006, de Molenaar et al. 2006). While it is difficult to extrapolate results of experiments on captive birds to wild populations, it is known that photoperiod (the relative amount of light and dark in a 24-hour period) is an essential cue triggering physiological processes as diverse as growth, metabolism, development, breeding behavior, and molting (de Molenaar et al. 2006). This suggests that increases in ambient light may interfere with these processes across a wide range of species, resulting in impacts on wildlife populations.

Artificial lighting may indirectly impact birds by increasing the nocturnal activity of predators such as owls, hawks, and mammalian predators (Negro et al. 2000, Longcore and Rich 2004, DeCandido and Allen 2006, Beier 2006). The presence of artificial light may also influence habitat use by breeding birds (Rogers et al. 2006, de Molenaar et al. 2006) by causing avoidance of well-lit areas, resulting in a net loss of habitat availability and quality.

Evidence that migrating birds are attracted to artificial light sources is abundant in the literature as early as the late 1800s (Gauthreaux and Belser 2006). Although the mechanism causing migrating birds to be attracted to bright lights is unknown, the attraction is well documented (Longcore and Rich 2004, Gauthreaux and Belser 2006). Migrating birds are frequently drawn from their migratory flight paths into the vicinity of an artificial light source, where they will reduce their flight speeds, increase vocalizations, and/or end up circling the lit area, effectively "captured" by the light (Herbert 1970, Gauthreaux and Belser 2006, Sheppard and Phillips 2015, Van Doren et al. 2017). When birds are drawn to artificial lights during their migration, they may become disoriented and possibly blinded by the intensity of the light (Gauthreaux and Belser 2006). The disorienting and blinding effects of artificial lights directly impact migratory birds by causing collisions with light structures, buildings, communication and power structures, or even the ground (Gauthreaux and Belser 2006). Indirect

impacts on migrating birds might include orientation mistakes and increased length of migration due to light-driven detours.

### Impacts Related to Up-Lighting

Up-lighting refers to light that projects upwards above the fixture. There are two primary ways in which the luminance of up-lights might impact the movements of birds. First, local birds using habitats on a site may become disoriented during flights among foraging areas and fly toward the lights, colliding with the lights or with nearby structures. Second, nocturnally migrating birds may alter their flight direction or behavior upon seeing lights; the birds may be drawn toward the lights or may become disoriented, potentially striking objects such as buildings, adjacent power lines, or even the lights themselves. These two effects are discussed separately below.

**Local Birds.** Seabirds may be especially vulnerable to artificial lights because many species are nocturnal foragers that have evolved to search out bioluminescent prey (Imber 1975, Reed et al. 1985, Montevecchi 2006), and thus are strongly attracted to bright light sources. When seabirds approach an artificial light, they seem unwilling to leave it and may become "trapped" within the sphere of the light source for hours or even days, often flying themselves to exhaustion or death (Montevecchi 2006). Seabirds using habitats associated with the San Francisco Bay to the north include primarily gulls and terns. Although none of these species are primarily nocturnal foragers, there is some possibility that gulls, which often fly at night, may fly in areas where they could be disoriented by up-lights under conditions dark enough that the lights would affect the birds. Shorebirds forage along the San Francisco Bay nocturnally as well as diurnally, and move frequently between foraging locations in response to tide levels and prey availability. Biologists and hunters have long used sudden bright light as a means of blinding and trapping shorebirds (Gerstenberg and Harris 1976, Potts and Sordahl 1979), so evidence that shorebirds are affected by bright light is well established. Though impacts of a consistent bright light are undocumented, it is possible that shorebirds, like other bird species, may be disoriented by a very bright light in their flight path.

Passerine species have been documented responding to increased illumination in their habitats with nocturnal foraging and territorial defense behaviors (Longcore and Rich 2004, Miller 2006, de Molenaar et al. 2006), but absent significant illumination, they typically do not forage at night, leaving them less susceptible to the attraction and disorientation caused by luminance when they are not migrating.

**Migrating Birds.** Numerous bird species migrate nocturnally in order to avoid diurnal predators and minimize energy expenditures. Bird migration over land typically occurs at altitudes of up to 5,000 feet, but is highly variable by species, region, and weather conditions (Kerlinger 1995, Newton 2008). In general, night-migrating birds optimize their altitude based on local conditions, and most songbird and soaring bird migration over land occurs at altitudes below 2,000 feet, while waterfowl and shorebirds typically migrate at higher altitudes (Kerlinger 1995, Newton 2008).

It is unknown what light levels adversely affect migrating birds, and at what distances birds respond to lights (Sheppard and Phillips 2015). In general, vertical beams are known to capture higher numbers of birds flying at lower altitudes. High-powered 7,000-watt (equivalent to 105,000-lumen) spotlights that reach altitudes of up to 4 miles (21,120 feet) in the sky have been shown to capture birds migrating at varying altitudes, with most effects occurring below 2,600 feet (where most migration occurs); however, effects were also documented at the upper limits of bird migration at approximately 13,200 feet (Van Doren *et al.* 2017). A study of bird responses to up-lighting from 250-watt (equivalent to 3,750-lumen) spotlights placed on the roof of a 533-foot tall building and directed upwards at a company logo documented behavioral changes in more than 90% of the birds that were visually observed flying over the building at night (Haupt and Schillemeit 2011). One study of vertical lights projecting up to 3,280 feet found that higher numbers of birds were captured at altitudes below 650 feet, but this effect was influenced by wind direction and the birds' flight speed (Bolshakov et al. 2013). These studies have not analyzed the capacity for vertical lights to attract migrating birds flying beyond their altitudinal range, and the potential for any project up-lights to affect birds flying at various altitudes is unknown. Thus, birds that encounter beams from up-lights are likely to respond to the lights, and may become disoriented or attracted to the lights to the point that they collide with buildings or other nearby structures, but the range of the effect of the lights is unknown.

Observations of bird behavioral responses to up-lights indicate that their behaviors return to normal quickly once up-lights are completely switched off (Van Doren et al. 2017), but no studies are available that demonstrate bird behavioral responses to reduced or dimmed up-lights. In general, up-lights within very dark areas are more likely to "capture" and disorient migrating birds, whereas up-lights in brightly lit areas (e.g., highly urban areas, such as Burlingame) are less likely to capture birds (Sheppard 2017). Birds are also known to be more susceptible to capture by artificial light when they are descending from night migration flights in the early mornings compared to when they ascend in the evenings; as a result, switching off up-lights after midnight can minimize adverse effects on migrating birds (Sheppard 2017). However, more powerful up-lights (e.g., 3,000 lumen spotlights) may create issues for migrating birds regardless of the time of night they are used (Sheppard 2017).

## Analysis of Potential Project Impacts on Birds due to Lighting

No detailed information regarding the project's proposed lighting design was available for review as part of this assessment. Nevertheless, construction of the project will create new sources of lighting on the site. Lighting would be the result of light fixtures illuminating buildings, building architectural lighting, pedestrian lighting, and artistic lighting. Depending on the location, direction, and intensity, this lighting can potentially spill into adjacent natural areas, thereby resulting in an increase in lighting compared to existing conditions. Areas immediately to the north, west, and east of the project site are primarily developed urban habitats that do not support bird communities that might be substantially affected by illuminance from the project. However, birds inhabiting more natural habitat areas along Burlingame Lagoon to the south may be affected by an increase in lighting.

Lighting from the project also has some potential to attract and/or disorient birds, especially during inclement weather when nocturnally migrating birds descend to lower altitudes. As a result, some birds moving along the

San Francisco Bay at night may be (1) attracted to the site, where they are more likely to collide with buildings; and/or (2) disoriented by night lighting, potentially causing them to collide with the buildings. Certain migrant birds that use structures for roosting and foraging (such as swifts and swallows) would be vulnerable to collisions if they perceive illuminated building interiors as potential roosting habitat and attempt to enter the buildings through glass walls. Similarly, migrant and resident birds would be vulnerable to collisions if they perceive illuminated vegetation within buildings as potential habitat and attempt to enter a building through glass walls.

Thus, because the project site is located in the immediate vicinity of natural areas along the San Francisco Bay, especially Burlingame Lagoon immediately south of the site, lighting associated with the project has a greater potential to (1) spill southwards into sensitive habitats along Burlingame Lagoon, and (2) attract and/or disorient migrating birds during the spring and fall, compared to buildings located farther inland in Burlingame.

The project will implement a general strategy to minimize lighting, as well as specific measures to ensure that the spill of lighting upwards and outwards into adjacent natural areas will be minimized to an appropriate level. With the implementation of these measures, which are listed under *Project Measures to Minimize Lighting* above, project impacts on birds due to lighting are less than significant under CEQA, in our professional opinion.

## Summary

Because birds are present in the vicinity of the proposed building, and glazed façades of the building may not always be perceived by birds as physical impediments to flight, we expect some avian collisions with the proposed building to occur. We expect collisions occur where glazing is located opposite vegetation or water within 60 feet of the ground, at transparent glass railings on vegetated balconies, and with areas of extensive glazing on the building's upper floors. However, the project design incorporates extensive opaque metal panels below 78 feet; bird-safe glass at spandrel glazing on the lower 60 feet of the building facing Burlingame Lagoon and areas of landscape vegetation where birds are most likely to occur; bird-safe glass at free-standing glass railings; glazing that is not highly reflective; and shadow boxes, mullions, and tinted glass above 78 feet that helps the building appear as a solid structure to birds in flight. In our opinion, these design features effectively reduce the potential for birds to collide with the building, and we do not expect the number of collisions to be so high over time as to result in a significant impact under CEQA.

Because the project site is located in the immediate vicinity of natural areas along the San Francisco Bay, especially Burlingame Lagoon immediately to the south, lighting associated with the project has a greater potential to (1) spill southwards into sensitive habitats along Burlingame Lagoon, and (2) attract and/or disorient migrating birds during the spring and fall, compared to buildings located farther inland in Burlingame. However, the project will implement a general strategy to minimize lighting, as well as specific measures to ensure that the spill of lighting upwards and outwards into adjacent natural areas will be minimized to an appropriate level. With the implementation of these measures, which are listed under *Project Measures to Minimize*

*Lighting* above, project impacts on birds due to lighting are less than significant under CEQA, in our professional opinion.

Please feel free to contact me at (408) 677-8737 or rcarle@harveyecology.com, or Steve Rottenborn at (408) 722-0931 or srottenborn@harveyecology.com, if you have any questions regarding this assessment. Thank you very much for contacting H. T. Harvey & Associates about this project.

Sincerely,

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Attachments: Résumés

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50 years of field notes, exploration, and excellence

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- 28 years of experience
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- Wetlands and riparian systems ecology
- Endangered Species Act consultation
- Environmental impact assessment
- Management of complex projects

### EDUCATION

PhD, Biological Sciences, Stanford University

BS, Biology, College of William and Mary

### PROFESSIONAL EXPERIENCE

*Principal,* H. T. Harvey & Associates, 1997–2000, 2004–present

*Ecology section chief/environmental scientist,* Wetland Studies and Solutions, Inc., 2000–04

*Independent consultant,* 1989–97

### MEMBERSHIPS AND AFFILIATIONS

*Chair*, California Bird Records Committee, 2016–19

*Member,* Board of Directors, Western Field Ornithologists, 2014–20

*Scientific associate/advisory board,* San Francisco Bay Bird Observatory, 1999–2004, 2009–18

*Member,* Board of Directors, Virginia Society of Ornithology, 2000–04

### PUBLICATIONS

Erickson, R. A., Garrett, K. L., Palacios, E., Rottenborn, S. C., and Unitt, P. 2018. Joseph Grinnell meets eBird: Climate change and 100 years of latitudinal movement in the avifauna of the Californias, in Trends and traditions: Avifaunal change in western North America (W. D. Shuford, R. E. Gill Jr., and C. M. Handel, eds.), pp. 12–49. Studies of Western Birds 3. Western Field Ornithologists, Camarillo, CA.

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Rottenborn, S. C. and E. S. Brinkley. 2007. Virginia's Birdlife. Virginia Society of Ornithology, Virginia Avifauna No. 7.

### PROFESSIONAL PROFILE

Dr. Steve Rottenborn is a principal in the wildlife ecology group in H. T. Harvey & Associates' Los Gatos office. He specializes in resolving issues related to special-status wildlife species and in meeting the wildlife-related requirements of federal and state environmental laws and regulations. Combining his research and training as a wildlife biologist and avian ecologist, Steve has built an impressive professional career that is highlighted by a particular interest in wetland and riparian communities, as well as the effects of human activities on bird populations and communities. Steve's experience extends to numerous additional special-status animal species. The breadth of his ecological training and project experience enables him to expertly manage multidisciplinary projects involving a broad array of biological issues.

He has contributed to more than 800 projects involving wildlife impact assessment, NEPA/CEQA documentation, biological constraints analysis, endangered species issues (including California and Federal Endangered Species Act consultations), permitting, and restoration. Steve has conducted surveys for a variety of wildlife taxa, including a number of threatened and endangered species, and contributes to the design of habitat restoration and monitoring plans. In his role as project manager and principal-in-charge for numerous projects, he has supervised data collection and analysis, report preparation, and agency and client coordination.

### PROJECT EXAMPLES

Principal-in-charge for **bird-safe design support for more than 40 development projects** in more than 10 cities throughout the San Francisco Bay area. This work has entailed preparation of avian collision risk assessments, sections of CEQA documents, assessments of project compliance with requirements of the lead agency, design recommendations (e.g., related to the selection of bird-safe glazing), and avian collision monitoring plans.

**Senior wildlife ecology expert on the South Bay Salt Pond restoration project** — the largest (~15,000-acre) restoration project of its kind in the western United States.

Served on the **Technical Advisory Committees/Expert Panels for the Santa Clara Valley Water District's Upper Penitencia Creek, One Water, Science Advisory Hub, San Tomas/Calabazas/Pond A8 Restoration, and Coyote Creek Native Ecosystem Enhancement Tool** efforts; selected to serve on these panels for his expertise in South Bay wildlife, restoration, and riparian ecology.

Led H. T. Harvey's work on the biological CEQA assessment and permitting for extensive/regional **facilities and habitat management programs for the Santa Clara Valley Water District, San Jose Water Company, County of San Mateo, and Midpeninsula Regional Open Space District**.

Contract manager/principal-in-charge for **Santa Clara Valley Water District's Biological Resources On-Call contract** (four successive contracts, with over 120 task orders, since 2009).

# Robin J. Carle, MS

## Wildlife Ecology

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H. T. HARVEY & ASSOCIATES
Ecological Consultants
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### HIGHLIGHTS

- 14 years of experience
- Avian ecology
- Environmental impact assessment
- Endangered Species Act consultation and compliance
- Nesting bird and burrowing owl surveys and monitoring
- Other special-status wildlife surveys and habitat assessments
- Bird-safe design

### EDUCATION

MS, Fish and Wildlife Management, Montana State University

BS, Ecology, Behavior, and Evolution, University of California, San Diego

### PERMITS AND LICENSES

Listed under CDFW letter permits to assist with research on bats, California tiger salamanders, California Ridgway's rails, and California black rails

USFWS 10(a)(1)(A) for California tiger salamander

### PROFESSIONAL EXPERIENCE

*Associate ecologist*, H. T. Harvey & Associates, 2007–present

*Volunteer bird bander*, San Francisco Bay Bird Observatory, 2010–2020

*Avian field technician*, West Virginia University, 2006

*Graduate teaching assistant*, Montana State University, 2003–06

*Avian field technician*, Point Blue Conservation Science (formerly PRBO Conservation Science), 2004

### PROFESSIONAL PROFILE

Robin Carle is an associate wildlife ecologist and ornithologist at H. T. Harvey & Associates, with more than 14 years of experience working in the greater San Francisco Bay Area. Her expertise is in the nesting ecology of passerine birds, and her graduate research focused on how local habitat features and larger landscape-level human effects combine to influence the nesting productivity of passerine birds in the Greater Yellowstone region. She also banded, sexed, and aged resident and migrant passerine birds with the San Francisco Bay Bird Observatory for 10 years. Her expertise extends to numerous additional wildlife species, and she has conducted surveys and assessments for burrowing owls; diurnal, nocturnal, and larval surveys for amphibians; acoustic and visual surveys for roosting bats; surveys and nest resource relocations for San Francisco dusky-footed woodrats; San Joaquin kit fox den surveys; trail camera surveys to document wildlife movement; and burrow-scoping surveys using fiber-optic orthoscopic cameras.

With an in-depth knowledge of regulatory requirements for special-status species, Robin has contributed to all aspects of client projects including NEPA/CEQA documentation, bird-safe design assessments, biological constraints analyses, special-status species surveys, nesting bird and raptor surveys and monitoring, construction implementation/permit compliance, Santa Clara Valley Habitat Plan/Natural Community Conservation Plan applications and compliance support, and natural resource management plans. Her strong understanding of CEQA, FESA, and CESA allows her to prepare environmental documents that fully satisfy the regulatory requirements of the agencies that issue discretionary permits. She manages field surveys, site assessments, report preparation, agency and client coordination, and large projects.

### BIRD-SAFE DESIGN EXPERIENCE

Provides bird-safe design support for **development projects for major technology companies in Sunnyvale and Mountain View** including the preparation of avian collision risk assessments, sections of CEQA documents, assessments of project compliance with City requirements, design recommendations (e.g., related to the selection of bird-safe glazing), avian collision monitoring plans, and calculations of qualification for LEED Pilot Credit 55.

Provided bird-safe design support for a **development project in Berkeley** including the preparation of an avian collision risk assessment and development of bird-safe design options that could be incorporated into the project.

Provided bird-safe design support for a **large development project in Menlo Park** with unique architecture and extensive glazing. Services included the preparation of an avian collision risk assessment and development of bird-safe design standards to reduce project impacts due to bird collisions to less than significant levels under CEQA.

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# Memorandum

**Project# 3305-03**

**March 24, 2023**

**To: Amy Wang, Project Manager, David J. Powers & Associates**

**From: Sharon Kramer, Scott Terrill, and Sophie Bernstein, H. T. Harvey & Associates**

**Subject: Final Assessment of the Potential Impacts of The Bay Lights 360 Project on Birds and Fish**

Per your request, H. T. Harvey & Associates is providing an assessment of the potential impact of The Bay Lights 360 Project on birds and fish. Drs. Scott Terrill and Sharon Kramer have reviewed the project description and are providing their assessments of potential project impacts to fish and birds.

Sharon Kramer has conducted research on fish ecology in Hawaii, Australia, and California/Oregon/Washington for her Masters of Science and PhD, with numerous publications. Scott Terrill conducted research on avian migration for both his Masters of Science and his PhD and has published approximately 30 scientific publications. He has conducted studies on bird migration in the United States, Mexico, Germany and Austria. Both resumes are attached as PDFs.

## Overview of the Project

The Bay Lights 360 Project (Project) proposes to extend the existing Bay Lights installation on the north-facing side of the upper deck level of the West Span[1] to 2033, and involves replacing existing light-emitting diode (LED) white lights on the Bay's (outward-facing) side of the vertical suspension cables and adding additional new fixtures to the driver's (inward-facing) side of the same cables. The existing LED lights will be removed, then replaced with newly updated and more robust fixtures (nodes) on the Bay's and driver's (outward- and inward- facing, respectively) sides of the same suspension cable to create a 360-degree view of the lights. Forty-eight thousand (48,000) energy-efficient LED lights, each 1.75 inches by 2.75 inches, will be installed, replacing the 30,000 existing fixtures (i.e., there will be 18,000 more fixtures than the existing display). The technical details and intensity of the lights will remain the same as the current installation (existing conditions).

The LED lights will be secured to the vertical suspension bridge cables on strings in full height of the suspension cables at one foot spacing. The light temperature will be 4,000 kelvin and brightness will be 87 lumens (at 100-percent brightness) for all fixtures, consistent with the existing lighting. The lights will be attached to the outer part of the bridge suspension cables with ultraviolet (UV) resistant heat stabilized nylon

[1] There are currently no LED lights, nor does the Project propose to install any, on the south-facing side of the upper deck of the Bay Bridge's West Span.

black zip ties at six-inch intervals, so no paint disturbances will occur to the bridge structure and no repainting will be required. Installation of the lights will not cause permanent disturbance to the bridge structure or ground disturbance off the bridge. Light fixtures can be replaced individually if needed.

The backbone fiber trunk line, power line and electrical boxes from previous installation will remain in place without modifications, except the internal back plate of the electrical boxes with the existing power supply and fiber switch components will be removed and replaced with new components.

The bridge lights will be visible from all directions (360-degree view) and will be lit from dusk to dawn. The light strands on both sides of the cables can be turned off or dimmed independently of each other with their own separate controls. The light fixtures can also be physically adjusted (rotated). The light display will be controlled by the artist and appear to be moving in a wave like and alternating flickering, non-repeatable but abstract pattern, consistent with existing conditions.

The Project will be installed over a period of four to six months during the evening/overnight hours, which will require nightly closures of the outside traffic lanes (lanes 4 and 5). It is anticipated that the proposed installation will start in May, 2023, and be fully installed by December, 2023. The new LED light strands will be installed from 9:00 p.m. to 5:00 a.m. Sunday through Friday nights, and from 11:00 p.m. to 6:00 a.m. Saturday nights if needed. The crews will utilize bosun chairs for the high cables and/or bucket trucks for the shorter cables (up to 80 feet) for the removal and installation.

The power usage for the energy-efficient LED system is estimated at maximum of 48 kilowatt-hours (kwh) based on 48,000 fixtures at one watt each, assuming all lights are on constantly. Daily energy equates to a maximum of 48 kwh times the number of hours the lights are on (between dawn and dusk), which thus changes throughout the year. Lights will be on for the longest duration during winter months.

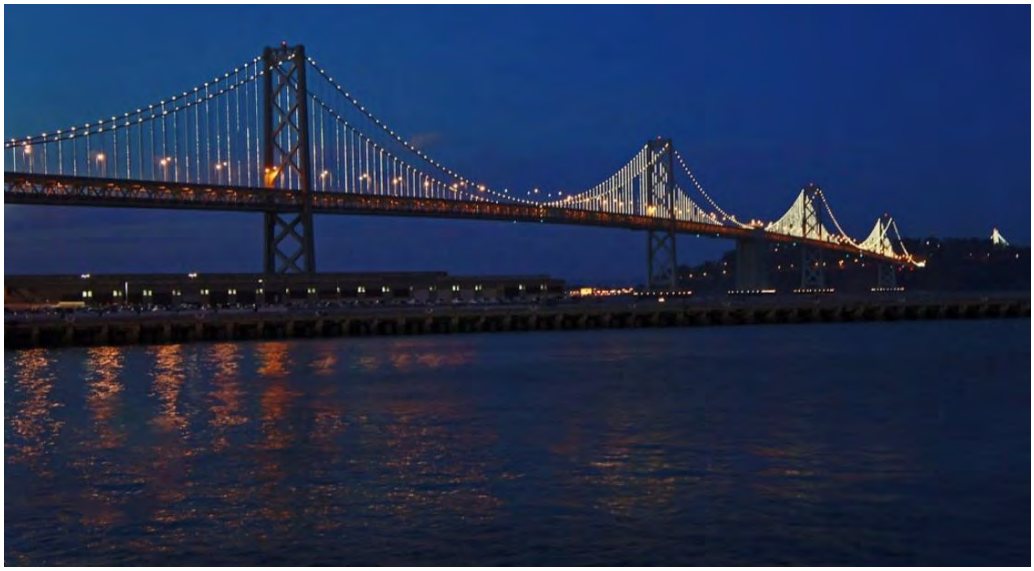

**Photo 1: Nighttime view of Bay Bridge with The Bay Lights art display partially visible looking west from the San Francisco shoreline, towards Yerba Buena Island and hills.**

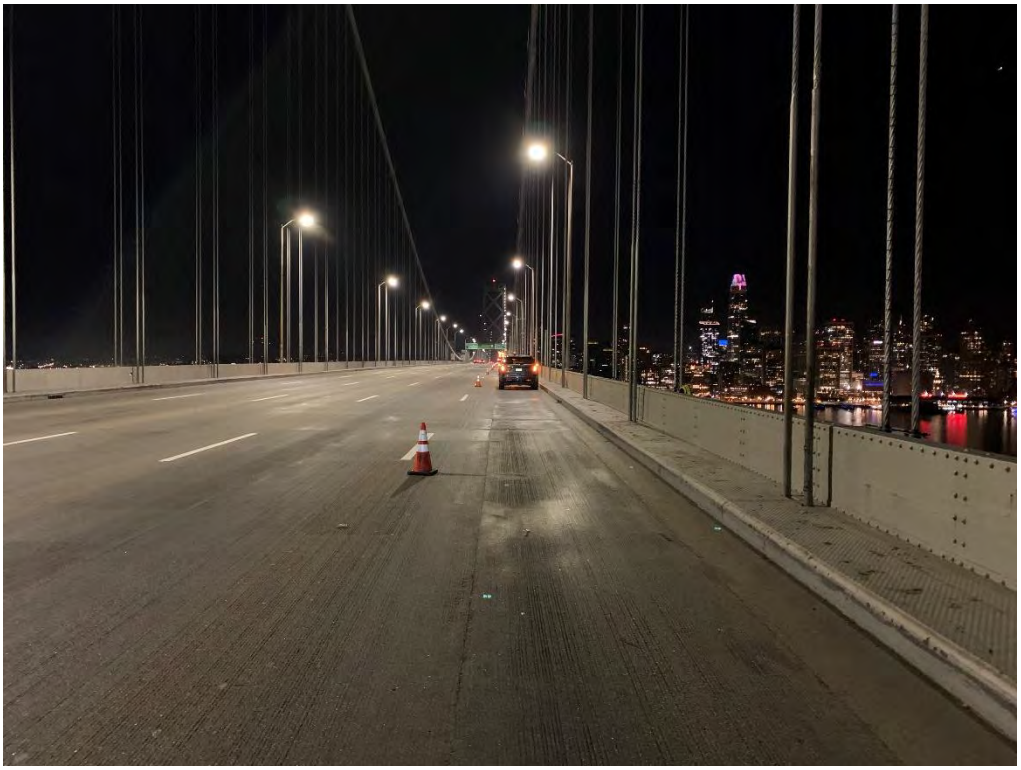

**Photo 2: Nighttime view of suspension cables of the Bay Bridge with The Bay Lights art display looking west, toward the San Francisco shoreline, from upper deck of the Bay Bridge.**

# Fish Assessment

Historically, aquatic biota were adapted to natural nighttime light, only affected by the moon, stars, cloud cover, biological luminescence, and aquatic biota (Nightingale et al. 2006). Within the last ~100 years, fish have been exposed to artificial lighting at night (ALAN) and the impacts of ALAN has become a focus of scientific research. This document reviews scientific information that has been published since the existing project was installed and provides updated information on the potential effects of the proposed The Bay Lights 360 Project on steelhead (*Oncorynchus mykiss*), green sturgeon (*Acipenser medirostris*), and Chinook salmon (*Oncorhynchus tshawyscha*), which are listed under the Federal Endangered Species Act (FESA), and California state-listed (California Endangered Species Act; CESA) longfin smelt (*Spirinchus thaleichthys*). Each of these taxa have potential to be present in the Project area. As detailed below, adverse effects to FESA and/or CESA listed fish are not anticipated.

## Species Review

### Steelhead

Both adult and juvenile steelhead swim past the Bay Bridge. Adult steelhead usually migrate from the ocean to tributaries in the South Bay where they spawn from late December through early April. Their greatest activity occurs from January through March, when flows are sufficient to allow them to reach suitable habitat in far

upstream areas. After hatching, juvenile steelhead remain in fresh water for one to four years before migrating to the ocean. The downstream juvenile migration occurs between February and May.

Acoustic telemetry of hatchery-reared steelhead smolts in the San Francisco Bay Estuary (SFBE) confirms that the region is primarily a migratory corridor (Chapman et al. 2015). Smolts were found to rapidly transit through the region (2-4 days), suggesting it is not used for rearing or smoltification, and that feeding in the area is opportunistic (Chapman et al. 2015). The majority of acoustic detections near the Bay Bridge were in the deeper channel along the western side, although this is likely a result of tidal effects and preference for deeper waters as opposed to their affinity for the location.

Unlike other Pacific salmonids, adult steelhead may survive and return to the ocean after spawning, and spawn for multiple seasons (Moyle, 2002). Their movements through the SFBE are likely rapid as well.

### Green Sturgeon

Green sturgeon are believed to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Green sturgeon in the SFBE spawn in the Sacramento River between March and July, with peak activity from April to June (Moyle et al. 1995, Adams et al. 2002, Miller et al. 2020). Juveniles spend 1-4 years in fresh and estuarine waters before migrating to the ocean (Beamesderfer and Webb 2002). Adults typically migrate into fresh water beginning in late February.

Information on green sturgeon has increased in recent years. Acoustically tagged green sturgeon have been reported to move relatively quickly through the SFBE to their spawning grounds (Miller et al. 2020). Other tracking studies in SFBE demonstrate how sturgeon detections are associated rapid movement and are distinctly directional, suggesting their use of the region as a migration corridor (Kelly et al. 2007; Lindley et al. 2011.). Their non-directional movement within the bay may be associated with foraging, when individuals move slowly and near the bottom (less than 33 feet deep) (Kelly et al. 2007). Green sturgeon have been found to be more active at night than during the day when in coastal marine waters (Erickson and Hightower 2007). However, in the Project region, activity appears to be independent of light level with no discernable peaks in activity at any particular time of day or light level (Kelly et al. 2007). Detections in the South Bay near the Bay Bridge peak between spring and summer, with peak presence between April, May and June (Miller et al. 2020).

### Longfin smelt

Longfin smelt are a coastal/estuarine fish that moves into freshwater or slightly brackish waters of the delta and Sacramento/San Joaquin rivers to spawn in winter/spring (Baxter 1999). The life cycle of longfin smelt is complex and they can be found throughout the entire estuary, from the freshwater Sacramento-San Joaquin Delta downstream to the south bay, reaching marine waters (Rosenfield and Baxter 2007; Merz et al. 2013). A conceptual model of their exact timing is provided in Merz et al. 2013. Long-term sampling in the SFBE has shown a consistent pattern of bathymetric distribution, where juvenile longfin smelt tend to occur in greater abundance in deep-water habitats as they migrate into marine environments during summer months (Rosenfield and Baxter 2007). Recent studies confirmed a new spawning and recruitment location for longfin smelt in tidal wetlands at the southern end of the South Bay, suggesting that adults and juveniles migrate under the Bay

Bridge on their seaward and spawning migration (Lewis et al. 2020). Limited information exists for the effects of ALAN on longfin smelt.

### Chinook salmon

Several runs of Central Valley Chinook salmon use the SFBE, and their timing within the bay depends on the run. Juveniles migrate through the SFBE on their seaward migration, and enter through either the main-stem of the Sacramento River or through secondary channels south of the main-stem of the Sacramento River (Perry et al. 2009), and adults return through on their spawning migration. Exact migration routes vary (Perry et al. 2009).

Recent tracking studies provide details on Chinook salmon movement and use of the SFBE. For example, acoustic tracking efforts of late-fall Chinook salmon smolts through SFBE (with receivers deployed along the Bay Bridge) provide information on their presence near the Project site as they migrate to sea: smolts were detected along the entire Bay Bridge, with greater detection frequency on the western side of the bridge where water is deeper, which aligns with a larger pattern that smolts rely on deeper channels for migration (Hearn et al. 2013). Their presence near the Bay Bridge was also relatively short in duration, and smolts were estimated to move rapidly through the bay within 2-4 days. Diel migration patterns (over 24-hour periods) of Chinook salmon smolts through the SFBE to sea suggest a routine preference for nocturnal movement (56.97% of detections occurred in the 14-hour 'darkness/night' period) (Chapman et al. 2013). However, the percentage of diel detections was lower in the estuary and nearby the Project site, compared to river spawning sites, the delta and ocean.

## Effects on Fishes

### Overview and previously described effects

Fishes are potentially affected by ALAN in several ways: changes to essential behaviors such as feeding, schooling, and migration, increased predation, and effects on metabolic processes and reproduction (Nightingale et al. 2006; Longcore et al. 2018a, b; Brayley et al. 2021). Similar to the existing installation, we expect impacts on fish to be associated with operation of the lights and not installation and removal. Once installed, the LED nodes for The Bay Lights 360 Project are not likely to represent a significant change from the existing conditions, even though there will be more nodes and fixtures on the bridge. The Project is not expected to affect spawning, since spawning of the previously described fishes is not likely to occur in the Project area. The Project is also not expected to delay migration past the bridge, because the SFBE and water below the Project area is primarily used as a corridor, and those moving through SFBE are likely using water quality cues to move quickly past the bridge. The Project is not anticipated to increase susceptibility of fishes to predation since the region is primarily a corridor, and as the bay already has high ambient light conditions and the light levels expected to reach the water will continue to be low. For example, it was estimated that approximately <0.02 lux[1] of additional indirect light would reach the water surface (note the Bay Bridge is already lit at night and there is an existing LED light sculpture that was first commissioned in 2013).

[1] Calculated using 12.3 lumens per node, for 5 strings on one suspension cable. Assumes light reaching the surface from each cable is not additive, using 250 ft as the approximate distance above the water.

Since the installation of the existing LED light sculpture, additional studies have been conducted on the impacts of ALAN on fishes. Recent studies cover topics, including, for example, assessments of ALAN impacts on predator density and predation (Nelson et al. 2021) and experiments related to differential attraction of fish to lights with varying wavelengths (Tabor et al. 2021). These studies continue to support findings on spawning, predation, timing and movements that were discussed in the Technical Memo in 2011 for the existing LED installation as described below:

- Adults likely use water quality cues to move quickly into tributaries used for spawning;
- Changes in light levels from shading or dock lights may interrupt salmonid movement, (Johnson et al. 2005; Rondorf et al. 2010), but the greatest impact affecting the movement of juveniles and their susceptibility to predation are from the dramatic changes in light levels during the day, from bright light to shading;
- Strobes deter fish from swimming into portions of dams or navigational locks where there is increased risk of injury or mortality. These strobes are powerful, synchronously flashing lights, not equivalent to light levels reaching the water surface; and
- The activity of certain salmonids in San Francisco Bay, including green sturgeon, are independent of light level without discernable peaks in activity throughout the day or based on light level (Kelly et al. 2007).

### Temperature effects

Since the installation of the existing project, the impact of LED light temperature on biota has become a research topic of interest. This is in part a result of the production of LED lights with spectral characteristics that can be controlled becoming more economically viable. Original LED lights provided full spectrum light by coating blue LEDs in phosphor. These LEDs had a high correlated color temperature (CCT), a lighting performance metric measured in degrees Kelvin (K), indicating a high proportion of blue and violet in the emissions (Longcore et al. 2018a). Generally, higher CCTs have greater effects on wildlife (Longcore et al. 2018a). Currently, more efficient LEDs with lower CCTs (associated with warmer, yellowish colors) and varying filtering technologies to reach a desired spectral signature exist and are competitive with older LEDs on the market (Longcore et al. 2018a).

Part of the reason LED light temperature has become a topic of interest is because technology has advanced to a degree where we can control for, and change, the light intensity, temperature, and spectral characteristics. Thus, more marine species are likely to be affected (Tidau et al. 2021, as lights that were previously outside of a species' visible light range and sensitivity may be replaced with lights of spectral signatures that are visible. Since this is a new field, limited species-specific information exists and work is ongoing.

A select few reviews incorporated salmonids into their analyses that help provide a gauge on the impact of light temperature. Longcore et al. 2018a developed an approach to predict the response of various taxa to different lamps based on their spectral output and identify response indices for a range of light sources, in an effort to minimize impacts on wildlife and avoid continual field studies. The two lamps with light temperatures similar to the ones used in the proposed Project (4000K) include the City of Los Angeles's (LA) LED Street Lights (4,300K) and the Yard Blaster (4,160K). These two lamps have nighttime performance indices that predict a

lower impact than the impact relative to a 6,500K standard (D65, daylight). Each additional lux (unit of measurement for light intensity and illumination) from LA's LED Street Lights and the Yard Blaster have 50% and 62% of the effect on salmonids as an additional lux from daylight. Given the Project's use of 4,000K LEDs, any increase in luminosity will have a lesser effect than an additional lux of daylight. With the Project's lights being well above the water column, the amount of light reaching the water is further decreased. Longcore et al. 2018a also calculated the actinic power, or spectral response and characteristic of radiation that represents the capacity for a chemical change. Actinic power for different lamps were expressed as a percentage of total power for salmonids, providing a light pollution metric to describe the amount of energy from the lamp's spectrum that impacts a species. Very few of the tested lights concentrate power in areas of the spectrum that are attractive to salmonids, and LA's LED Street Lights and the Yard Blaster are several magnitudes lower than the standard for daylight lux (30 for D65, 27 for LA Lights and 29 for Yard Blaster). Lastly, the slope of the relationship between CCT and impact on juvenile salmonids is relatively steep compared to other taxa, with lower CCTs associated with lower predicted effects. This suggests that lower CCT LEDs may be an effective tool in reducing impacts on juvenile salmon (Longcore et al. 2018b). The light temperature of the display is not expected to change relative to existing conditions.

Although research has been conducted on static versus dynamic LEDs with varying light spectra with respect to effects on fish, it has not fully explored the difference between static versus dynamic lights of varying temperatures. For example, studies have assessed the ability to use LED's of varying spectra for behavioral guidance, particularly as a means to repel them from entrapment (Hansen et al. 2018, 2019). A 2018 experiment testing the movement and spatial responses of salmonids to varying combinations of LED spectra and those with different strobing frequencies found that the behavioral response of Chinook salmon smolts depended on the light spectra and time of day (Hansen et al. 2018). While red light repelled fishes during the day, there was no effect of any light spectra at night. Strobing did not alter fish behavior at night or during the day (Hansen et al. 2018). A follow up study focusing specifically on the ability to use LED strobes of emitting different spectral signatures to divert migrating Chinook salmon smolts found that strobing lights of all wavelengths increased entrainment compared to the absence of light, and entrainment increased at night, with blue and white strobing lights having a stronger effect than strobing red LEDs (Hansen et al. 2019).

Despite the need for ongoing research to identify species-specific responses to dynamic LEDs of varying spectra and temperature, conditions for the proposed Project are not expected to be different from the existing conditions.

# Avian Assessment

This section of the document reviews scientific information that has been published since the existing project was installed and provides updated information on the potential effects of the proposed The Bay Lights 360 Project on avian species. As detailed below, adverse impacts to avian groups are not anticipated, except for the potential to affect avian species during installation if nests are impacted during breeding season.

### Direct effects of light installation and removal

In general, the installation of the lights should not disturb breeding birds to the point of abandonment, unless the work is to occur in such a way as to directly impact the nests of breeding individuals. If the lights are

installed between late fall and early winter, the installation will fall outside the primary breeding season and not be a potential issue. If the lights are installed during the breeding season, it should not significantly increase human activity levels relative to existing conditions with respect to local birds, which are habituated to the traffic and other anthropogenic activities associated with the bridge. If installation is to occur during the breeding season (February-September), it is recommended that a biological monitor be present. If an active nest that might be directly impacted (including disturbing adults to the point of nest abandonment) is detected, the Regulatory Resource Agencies (California Department of Fish and Game / United States Fish and Wildlife Service) should be contacted to consult on avoidance measures. Potentially breeding birds on the Bay Bridge include cormorants and peregrine falcons, however these birds primarily breed below the traffic bearing portions of bridge structures, which lie below the Project activity.

The removal of the lights should involve the same considerations as the installation. If the lights are removed after the avian breeding season (i.e., "late in 2023"), there would be no impacts to breeding birds.

### Indirect effects of installed lighting

The lighting should not have a significant impact on birds. Nocturnal migrants collide primarily with towers and other structures that are lit with constant white light (Gauthreaux and Belser 2006). These birds also collide with buildings that have lit windows at night during migration. This phenomenon is most pronounced in eastern and central North America (likely due to increased numbers of migrant birds relative to western North America; Horton et al. 2019) and, with respect to towers, collision typically occurs when guy wires secure the towers. Strobe lights and colored lights (especially green) substantially reduce the collision rates of migrants with lit structures (Gauthreaux and Belser 2006). A field study in the in the North Sea found that nocturnally migrating birds were disoriented and attracted by red and white light, whereas they were "clearly less disoriented by blue and green light" (Poot et al. 2008). Multiple studies have found that flashing or blinking lights are less attractive to migrating birds relative to continuous light (Gauthreaux and Belser 2006; Gehring et al. 2009) and several have found that numbers of birds around blinking modes (intermittent, continuous) did not differ from numbers of birds under darkness conditions (Rebke et al. 2019). In the case of The Bay Lights 360 Project, the lights on display are not single-source, nor static. The movement patterns associated with the lighting scheme should not attract or disorient (leading to collision of) migrants. The addition of constant white lighting sources to the existing light installation on the bridge during nighttime construction could slightly increase the likelihood of collision for nocturnally migrating birds, especially during foggy or stormy nights. However, the bridge is already well lit at night for safety reasons.

As indicated above, higher CCTs generally have greater effects on wildlife (Longcore et al. 2018a). Currently, recommendations for reducing effects on biota vary from less than or equal to 3000 to 2700 (e.g., Longcore et al 2018; International Dark Sky Association: https://www.darksky.org/). In the case of potentially attracting nocturnally migrating birds, we know of no research on the effects of differential light temperature in blinking versus static LED lights. However, research indicates no difference in the attractiveness of dynamic lights that are of different colors (which translates into varying temperature) (Rebke et al. 2019).

Nocturnal migrants (especially passerines or songbirds), may be attracted to the horizon glow and overall lighting of populated areas in general. However, no negative effects of such attraction have been demonstrated. Under current conditions, given the amount of artificial light associated with development in the San Francisco Bay Area (including the current lighting on the Bay Bridge itself), the installation of new LED lights would not significantly add to the overall lighting in the region.

Similarly, the lighting should not affect waterbirds or shorebirds associated with the Bay, including birds breeding on the bridge. These birds are well below portions of the bridge that will be lit by this Project, and are associated with water as opposed to structures. Migrant shorebirds flying at bridge height should be able to easily detect and avoid the bridge in most conditions. Under foggy conditions, the lighting may even increase the probability of detection and avoidance by these birds.

In summary, while higher temperature lights may have an increased effect on birds and other wildlife, research reviewing the attractiveness of blinking lights versus static lights indicates that impacts of static lighting are not associated with dynamic lighting of the same color temperatures.

# Overall Summary

The Bay Bridge and vicinity in San Francisco Bay is currently extremely well-lit with artificial light at night. Based on our analysis of the proposed Project and updated scientific information since the original project memo, the additional lighting from the Bay Bridge 360 Project is not anticipated to have additional effects on listed fish or avian species, except for the potential to affect avian species directly during installation if nests are impacted during breeding season. A San Francisco Bay Conservation and Development Commission (BCDC) permit will be required, as the scope of the proposed Project represents a minor repair or improvement, and there are potential listed species in the area

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