2.3 NON-AGENCY ORGANIZATIONS COMMENTS AND RESPONSES

The following non-agency organizations have submitted comments on the Draft EIR.

Table 2.3-1. Non-Agency Organization Comment Documents Received

Respondent	Code	Contact Information	Page
The Climate Reality Project, Los Angeles Chapter Letter dated: October 23, 2023	TCRP	Email: charlesallenmiller@gmail.com *Contact: Charles Miller, Chair*	2.3-3
Los Angeles Audubon Society Letter dated: October 24, 2023	LAA	P.O. Box 931057 Los Angeles, California 90093-1057 *Contact: Travis Longcore, Ph.D., President*	2.3-11
Los Angeles Conservancy Letter dated: October 26, 2023	LAC	523 West Sixth Street, Suite 826 Los Angeles, CA 90014 *Contact: Adrian Scott Fine, Senior Director of Advocacy*	2.3-113
Neighborhood Council Sustainability Alliance of Los Angeles Letter dated: October 26, 2023	NCSA	Email: ncsa@empowerla.org *Contact: Lisa Hart, Executive Director*	2.3-124
Park La Brea Impacted Residents Group Letter dated: October 26, 2023	PLBIRG	351 South Fairfax Avenue, #421 Los Angeles, CA 90036 *Contact: Barbara Gallen, Co-President*	2.3-136

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2.3.1 The Climate Reality Project, Los Angeles Chapter

The Climate Reality Project
LOS ANGELES CHAPTER

October 23, 2023

Leslie Negritto, Chief Operating Officer
Natural History Museums of Los Angeles County
900 Exposition Boulevard
Los Angeles, California 90007
Via e-mail: lnegritto@nhm.org, reimagine@tarpits.org

RE: Public Comment On Proposed La Brea Tar Pits Master Plan Project

Dear Chief Operating Officer Negritto:

The Los Angeles Chapter of the Climate Reality Project, which has 1500 members and is the largest local chapter connected to the international Climate Reality Project, submits this public comment to the Natural History Museums of Los Angeles County (NHM) regarding the La Brea Tar Pits Master Plan Project. We have concerns about the project as presented which we feel are reasonable and can be accommodated without major cost or delay. **TCRP-1**

We believe there are specific adjustments to the landscaping plan that will improve the sustainability, historical value, and cultural significance of the project. Accordingly, we request that the following changes be incorporated into the design.

1) Allow biofiltration areas to recharge groundwater and irrigate lawn.

As outlined in DEIR Section 3.4.7.2, the three biofiltration spaces will be lined with an impermeable liner, and water will be routed to the city stormwater drains. This is a missed opportunity. Central to the function of a true bioswale is the absorption of water for groundwater recharge. This can only be accomplished if the bioswale (or biofiltration planter) does not reside over an impermeable barrier. **TCRP-2** Therein, an unlined or partially unlined bottom in each of the three biofiltration spaces would have greater benefit to the community and the urban ecosystem by allowing some groundwater recharge. Of particular significance is that Oil Creek is a naturally occurring spring that is a fundamental component of the very system and unique phenomenon that the park celebrates. To add impermeable barriers to such a system undermines the functionality of a unique historical site, diminishing its educational value and threatening the existence of the Oil Creek spring. **TCRP-3** Importantly, it is counterintuitive to use natural systems to filter onsite water, only to dump it back into the city stormwater drain system, where it will be polluted again before reaching our local watershed. Certainly any flooding concerns could be addressed with overflow drainage in the bioswale and bioplanter designs. Groundwater flow is an inherent element of Oil Creek.

The immense footprint of grass lawn in the project underscores the need to utilize onsite water sources rather than dumping naturally cleaned water into the stormwater drain. Overflow water cleaned by the biofiltration spaces should be captured as an irrigation source to offset the significant impact of using potable water to irrigate the grass lawn in the project. **TCRP-4**

2) Redesign the landscaping plan to save / incorporate four historically significant tree specimens. **TCRP-5**

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The area to the northwest of the current Central Green, south of the current Pleistocene garden, contains two old-growth *Rhus ovata* (Sugarbush) and one old-growth *Heteromeles arbutifolia* (Toyon). These are visible (albeit difficult to identify) in Existing Site Figure 3-3 in the DEIR. We believe the two *Rhus ovata* are the largest specimens in the City of Los Angeles and among the largest in existence for this regionally local species. Likewise, the *Heteromeles arbutifolia*, a species declared the official native plant of Los Angeles by City Council in 2012 and a protected tree species via Los Angeles Ordinance 186873, has historical and cultural significance. A 1924 overhead photo of the site in the Los Angeles Public Library archives shows probable evidence of these three trees existing on the site a century ago. Further northwest of these three trees, north of Oil Creek and a few feet northwest of the current Pleistocene garden, is an exceptional example of *Aesculus californica* (California Buckeye) that also carries significance as being among the largest examples in the City of Los Angeles. Though the DEIR lacks a tree inventory and specifics on exactly which trees will be preserved, preliminary documents suggest all four of these trees are slated for removal. Due to their age and size, these four trees are poor candidates for survival if moved, even if the large expense and effort to do so was undertaken. However, an overlay of the Conceptual Site Plan in Figure 3-4 onto Figure 3-3 suggests these four trees are outside the proposed new building footprint and could be accommodated and preserved with minor alterations to the landscaping design. **TCRP-5 (cont'd)**

Consider that the project site also includes two mature *Sequoia sempervirens* (Coast Redwood), two mature *Umbellularia californica* (California Bay Laurel), and several mature *Pinus torreyana* (Torrey Pine). These native trees are among the largest trees on the site, and a superior plan would have designed around them. *Umbellularia californica* is a protected species in Los Angeles and *Pinus torreyana* is an endangered species that is the rarest pine species in the United States. However, because they are within the footprint of a new building in the DEIR, we don't see how they can be saved without a major redesign of the project. The loss of these trees will constitute a significant harm to the ecosystem of the area and the cultural heritage of the region. **TCRP-6** This makes it all the more imperative that the four trees listed in the prior paragraph (which can be saved with comparatively minimal effort) be saved. **TCRP-7**

3) Removal of any native tree protected by Los Angeles Ordinance 186873 should result in the full 4:1 replacement ratio planted on site within the project boundaries.

Though this is a County facility, it is situated in the City of Los Angeles, which has a Protected Tree Ordinance in place to discourage the removal of native trees and shrubs. The project should not attempt the use of a legal technicality to avoid the spirit in the law of the City of Los Angeles, as supported by the stakeholders of the community. **TCRP-8** The existing site contains multiple healthy mature specimens of these five protected tree species (*Heteromeles arbutifolia* (Toyon), *Platanus racemosa* (Western Sycamore), *Umbellularia californica* (California Bay Laurel), *Sambucus mexicana* (Blue Elderberry), and *Juglans californica* (Southern California Black Walnut)) and one protected tree genus *Quercus* (Oaks) of native origin as defined in Los Angeles Ordinance 186873. **TCRP-9** Many of these are slated for removal. The project site is noteworthy for having all these species in a relatively small area that is easily walkable and accessible, and consequently serves as an extremely valuable education tool in addition to having the biodiversity benefits these native trees provide. Section 3.4.7.1 of the DEIR estimates that 135 to 180 trees (including many non-native trees) in the existing site will be removed, assuming the calculation that an additional 10 percent will be relocated. This is a significant loss of mature tree canopy for the **TCRP-10**

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community, with decades-long loss of shade, carbon capture, and heat-island effect offset. Installing the full 4:1 replacement ratio of our protected species on site as part of the new design is an important long term mitigation to these losses. **TCRP-10 (cont'd)**

4) The removal of any *Berberis nevinii* (Nevin's Barberry) should also result in a 4:1 replacement ratio planted on site within the project boundaries.

Berberis nevinii is a federally and state listed endangered species. Several large, mature examples of this shrub are at the existing site, specifically within the current Pleistocene garden—an area slated for removal in current plans. Though these plants were planted by humans, they are well established at the location. The new plant palette designs in Figures 3-12, 3-13, and 3-14 of the DEIR do not include plans for *Berberis nevinii*. While relocation of the existing on site mature shrubs is technically possible, this may have a low success rate beyond the short term. By incorporating new plantings of this species into the design, a long term presence for this endangered species can be secured. **TCRP-11**

5) All new plantings, other than functional lawn, must be native species, with a preference for species from the tar pits fossil record.

The original vision of this park as articulated by naturalist Theodore Payne and landscape architect Ralph Cornell over a century ago was to feature an exclusively native plant habitat. This project offers a singular opportunity to bring that vision closer to reality, and there are extremely important reasons to do so. **TCRP-12** Los Angeles is experiencing a biodiversity crisis, having lost over 90% of our local pollinators since the beginning of the twentieth century. Key Lepidoptera species (butterflies and moths) are disappearing to extinction at the rate of two regional species per year. Because many specialist fauna depend on the native plants with which they have evolved, native landscaping plants and trees provide essential support for local biodiversity. There is not a better case for an all-native urban landscaping design than that of Hancock Park in the La Brea Tar Pits Master Plan Project, a space noteworthy for being the most important Pleistocene fossil site on the planet. The tar pits have established a fossil record with tens of thousands of years of evidence of our native plants surviving climate change and varying carbon levels that exceed those anticipated from anthropogenic climate change. These changes were a factor in wiping out the famous megafauna displayed in the Page Museum at the tar pits, yet our surviving local native plants endured these changes. **TCRP-13**

As a demonstration of the power of adaptability within the DNA of our local native plants in our unique biodiversity hotspot, the project site has unparalleled importance as an education tool for climate change and biodiversity, but only if the landscaping design utilizes those native plant species. Happily, the creators of the DEIR document seem to get this, as all the proposed species in Sections 3.4.7 and 3.4.7.1 and the aforementioned Figures of the DEIR exclusively reference native species. However, suggested plant palettes are different from actual detailed landscaping plans. **TCRP-14** In conversations with several members of the landscape design team, our members were repeatedly told that new landscaping installations would be "90 to 95 percent native" with some members of the design team going on to mention plans to install multiple exotic trees such as *Tipuana tipu*. There is no scientific, cultural, or practical justification for including non-native tree species in the planting palette of this project. With well over 70 locally native tree and shrub species and hundreds of local herbaceous plant species providing **TCRP-15**

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ample choices for both drought resistant landscaping as well as the project's riparian biofiltration areas, no credible argument can be made that it is biologically valuable or necessary to add more ornamental non-native species to this site (a site that will still contain over 100 mature non-native trees slated for preservation in the current plan).

Furthermore, even the "90 to 95 percent" natives suggested by designers is greatly misleading. Consider that a large percentage of the 13 acres in both the existing site and proposed site in the DEIR consists of non-native grass species for open lawn. Thus, the native percentage estimate by designers omits the lawn that will constitute the highest percentage of planted biomass for the project. While lawn has a functional green space value for the community, the ornamental landscaping trees and other non-lawn plants added to this site, going forward, should be exclusively native in recognition of the historical significance of the plants in the fossil record that make this site a true treasure for the local community, region, and world. **TCRP-15 (cont'd)**

Thank you for this opportunity for public comment. We hope the Los Angeles Climate Reality Project, an organization committed to equitable and urgent climate action wherever possible, can serve as an advisor on this project as it moves forward. We support NHM for its ambitious goals. **TCRP-16**

Sincerely,

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Climate Reality Project
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2.3.1.1 Response to Letter from The Climate Reality Project, Los Angeles Chapter

Comment No.	Response
TCRP-1	The comment provides an overview of the Los Angeles Chapter of the Climate Reality Project and introduces the letter, indicating that the Climate Reality Project requests changes to the proposed project. Responses to the specific comments in the letter are provided below. The County would like to thank the commenter for participating in the public review process of the Draft EIR. A copy of this comment letter will be included in the Final EIR, which will be provided to the Board of Supervisors for review when the project is considered for approval. It is important to note that this letter does not state any concern or critique of the analysis contained within the Draft EIR. However, the County is providing responses to the concerns raised to provide as much information and transparency to the commenter and interested parties as possible. Throughout the comment letter, the Climate Reality Project requests specific adjustments to the landscaping plan that the commenter believes would improve the sustainability, historical value, and cultural significance of the project. After receiving comments on the Draft EIR, the project proponent, the County Museum of Natural History, considered the comments made by the commenting entities, including the Climate Reality Project, and refined the design of the improvements proposed at the La Brea Tar Pits site, including the landscaping plan and what features could be retained and/or protected and to what degree. As a result, the County has proposed of a variation of the Master Plan which is described in the Final EIR. Refer to **MR-1, Preferred Alternative, MR-2, Impacts to Native and Mature Trees,** and **MR-3, Use of Native Plants and Vegetation,** for more information regarding the additional information provided by the updated designs, Refined Alternative 3, and the County's commitment to meet and exceed the regulatory requirements for impacts to trees and other vegetation at the La Brea Tar Pits site.
TCRP-2	The commenter shares the opinion that the bioswales included in the project (as described in the EIR) should be redesigned without an impermeable liner because the use of an impermeable liner limits the ability for the bioswales to recharge the site's groundwater. While this is not a comment on the environmental impact analysis contained in the EIR, additional information is provided within this response to provide an understanding of the rationale for the proposed bioswale approach. It is correct that the use of an impermeable liner would limit the bioswale's ability to recharge groundwater. However, the proposed bioswale is intentionally designed this way. Further, groundwater recharge is not an objective of the proposed project. Due to the conditions of the project site, constructing a permeable bioswale would not be feasible. Bioswales relying on permeable basins require the composition of the local soil to allow for a high enough infiltration rate in order to avoid any standing water. This is because standing water can lead to vector control issues, by potentially providing a breeding ground for mosquitos and other harmful organisms. The project site's soil composition includes clays and tar sands which would not allow stormwater to infiltrate into the ground at a high enough rate to avoid standing water. As well, groundwater must not be found less than 10 feet from the bottom of the bioswale, in order to allow for adequate filtration to reduce the amount of surface pollutants entering the groundwater. Groundwater at the project site has been discovered less than 10 feet from the surface, which would not allow stormwater to be adequately filtered prior to entering the groundwater. Lastly, since the site's soil includes clays and tar sands, this composition would further limit the ability for stormwater to infiltrate into the ground at high enough rates to allow for adequate filtration. Given the soil and groundwater conditions at the project site, the most feasible option is the use of bioswales which rely on stormwater bioretention basins, as proposed by the project. These types of bioswales consist of a raised planter system with a retention basin and an underdrain. They can be designed to be permeable, however certain site conditions may require an impermeable barrier. For the proposed project, the bioswales would be required to include an impermeable liner for two reasons. First, due to the presence of high groundwater, if the bioswale did not include an impermeable liner, the underdrain could continuously capture the site's groundwater leading to unnecessary discharge. Second, without an impermeable barrier, the tar seeps present in the site's soil would enter and clog the drainage system, reducing the effectiveness of the bioswale. For these reasons, permeable bioswales are not possible on the project site. No changes to the EIR were determined to be necessary in response to this comment.
TCRP-3	This comment states that the use of bioswales with impermeable liners would undermine the functionality of the project site. As discussed in TCRP-2, the bioswales on the project site must be designed with an impermeable liner. However, the bioswales proposed would still be able successfully capture significant amounts of stormwater runoff and would reduce the potential for surface pollutants to further contaminate any groundwater present at the project site. No changes to the EIR were determined to be necessary in response to this comment.

Comment No.	Response
TCRP-4	The comment states that overflow water from the proposed bioswales should be captured for re-use on the project site. The County requires that all captured stormwater must be re-used within 96 hours to reduce the potential for vector control issues, as discussed in TCRP-2. Since the project will be landscaped with low-water use plants, it is anticipated that the demand required for reused water would not be met. EIR Sections 5.9 Hydrology and Water Quality and 5.15 Utilities include analyses with the assumption that water on the project site would not be recycled. The EIR concluded that the project would have less-than-significant impacts to hydrology and water quality as well as utility and service systems, with the implementation of identified mitigation measures. Therefore, no changes to the EIR were determined to be necessary in response to this comment.
TCRP-5	The commenter requests that the landscaping plan be redesigned to save the four tree specimens that have been highlighted by the Climate Reality Project as having value to the community because of their age. Specifically, these are identified by the commenter as two old-growth Sugarbush, one old-growth Toyon, and one California Buckeye. Appendix N has been added to the Final EIR which provides the tree inventory completed by the design team for the project. The location of the trees identified by the commenter can be found in this appendix, which includes tree locations and species identification. The exact trees to be removed through implementation of the project have not yet been determined. The trees at the project site do not have any historic designation. The County will prioritize the protection of these trees and will avoid their removal if feasible while also meeting the budgetary and design needs for the project. Retention of these trees may not be possible due to several issues related to feasibility of retention. These include the excavation requirements for construction of the building and the relative proximity of the trees to the new building location, planned park accessibility improvements, and fire access requirements. The County will continue to refine the designs as the project develops to account for the most protections possible for native and community resources. This may include protection of individual tree species noted as important to the community and/or increases in replacement ratios for trees that are particularly valued by the community. However, because the property is not regulated by the City of Los Angeles, the replacement ratio set by the City of Los Angeles is not required to be met. The environmental analysis regarding vegetation and local tree impacts that is contained in Section 5.3 of the EIR is an accurate assessment of the potential for significant environmental impacts regarding tree and vegetation removal. No changes to the EIR were determined to be necessary in response to this comment. Refer to **MR-2, Impacts to Native and Mature Trees**.
TCRP-6	The commenter opines that a superior plan would have been to design around the California Bay Laurel and several mature Torrey Pines. Appendix N has been added to the Final EIR which provides the tree inventory completed by the design team for the project. Appendix N includes tree locations and species identification. The exact trees to be removed through implementation of the project have not yet been determined. While there is not a requirement to protect or preserve these trees, the County will prioritize the protection of these trees and will avoid their removal if feasible while also meeting the budgetary and design needs for the project. No changes to the EIR were determined to be necessary in response to this comment. Refer to **MR-2, Impacts to Native and Mature Trees**.
TCRP-7	The commenter reiterates that the four trees listed (two old-growth Sugarbush, one old-growth Toyon, one California Buckeye) be saved. No changes to the EIR were determined to be necessary in response to this comment. Refer to **MR-2, Impacts to Native and Mature Trees,** and Responses TCRP-5 and TCRP-6.
TCRP-8	The commenter indicates that the City of Los Angeles Ordinance 186873 should be followed, which would result in different replacement ratios than what is being proposed or required for the project. Wherever possible, the County will provide for higher replacement ratios than what is required by the regulatory requirements that apply to the project. However, the requirements set by the City of Los Angeles do not apply to the project, as the property is subject only to the regulatory requirements of the County of Los Angeles. The County and the project design team will continue to refine the designs as the project develops to account for the most protections possible for native resources. This may include possible voluntary increases in replacement ratios. However, the requirements identified in the EIR are not required to be revised as they are consistent with the regulatory requirements that apply to the project and what is necessary to reduce impacts to mature trees to less than significant. These measures are included in the EIR as Mitigation Measures BIO/mm-5.2, BIO/mm-6.1, and BIO/mm-6.2. No changes to the EIR were determined to be necessary in response to this comment.
TCRP-9	The commenter identifies additional trees that they feel should be protected with development of the Master Plan even though the project site is not subject to the City of Los Angeles regulations. Refer to **MR-2, Impacts to Native and Mature Trees**, and Responses TCRP-5, TCRP-6, and TCRP-8. No changes to the EIR were determined to be necessary in response to this comment.

Comment No.	Response
TCRP-10	The commenter indicates that the project site is noteworthy for having many identified tree species in a relatively small area and consequently serves as a valuable education tool. Further, the commenter indicates that Section 3.4.7.1 of the DEIR estimates that 135 to 180 trees (including many non-native trees) in the existing site would be removed, assuming the calculation that an additional 10% would be relocated. The County agrees with the commentor that the site is an important educational resource. The designs for improvement and development at the La Brea Tar Pits project site are intended to amplify the educational resources at the site, including the thought that has been put towards the proposed landscaping plan. The plant palette that is being proposed responds to the existing park setting and the historical significance of the site; it is based on the native vegetation of the Los Angeles Basin and was informed by research gathered from the La Brea Tar Pits fossil record. The palette specifically highlights plants which were previously present at La Brea Tar Pits as historical floral communities. The plant palette also prioritizes pollinator resources. As correctly reflected by the commenter, while some trees and vegetation would be required to be removed to fully realize the design of the Master Plan, the landscaping concept for most of the site responds to the native vegetation of the Los Angeles basin and has been informed by the research gathered from the fossil record of La Brea Tar Pits. Also, the plant palette consists primarily of California natives. The commenter's estimate of the number of trees that would be removed is within the range currently estimated by the County and the design team, although this is only as estimate at this time. It should also be noted that the project would result in an increase in the number of native trees at the project site. These native trees are more resilient and likely to survive and thrive over the long term as they are uniquely adapted to the local southern California climate. Refer to **MR-2, Impacts to Native and Mature Trees,** and **MR-3, Use of Native Plants and Vegetation**, as well as Responses TCRP-5 and TCRP-8. No changes to the EIR were determined to be necessary in response to this comment.
TCRP-11	The commenter expresses that any removal of Nevin's Barberry should be replanted with a 4:1 replacement ratio. There are two Nevin's Barberry on site located in the Pleistocene Garden, which is proposed to be removed to accommodate grade changes for building and park improvements and the addition of a fire lane. However, this species can be included in the plant palette and incorporated into the design where appropriate. The requirements set by the City of Los Angeles do not apply to the project, as the property is subject only to the regulatory requirements of the County of Los Angeles. The County will continue to refine the designs as the project develops to account for the most protections possible for native resources. This may include voluntary increases in replacement ratios. However, a specific replacement ratio is not required beyond the requirements specified in Mitigation Measure BIO/mm-6.1. No changes to the EIR were determined to be necessary in response to this comment.
TCRP-12	The commenter requests that all new plantings be native species, with a special preference for species found in the tar pits fossil records, as the park was originally envisioned to exclusively feature native plants. While this is not a comment specifically on the analysis contained in the Draft EIR, it should be noted that native species have been prioritized in the plant palette and incorporated into the design where appropriate. The plant palette was developed based on the native vegetation of the Los Angeles Basin and was informed by research gathered from the La Brea Tar Pits fossil record. The County will continue to refine the designs as the project develops to account for the most protections possible for native resources. No changes to the EIR were determined to be necessary in response to this comment. Additionally, refer to **MR-3, Use of Native Plants and Vegetation**.
TCRP-13	The commenter states that it is critical that native plants are incorporated in the project's design as Los Angeles is currently experiencing a biodiversity crisis. As discussed in Response TCRP-12, native plants are prioritized in the plant palette, which specifically highlight plants which are present in Tar Pits fossil record. Furthermore, it should be noted that the plant palette also contains considerations for historical floral communities and pollinator resources. The County will continue to refine the designs as the project develops to account for the most protections possible for native resources. No changes to the EIR were determined to be necessary in response to this comment. Additionally, refer to **MR-3, Use of Native Plants and Vegetation**.
TCRP-14	The commenter emphasizes that the project site has unparalleled importance as an education tool for climate change and biodiversity, but only if the landscaping design utilizes those native plant species. The commenter also expresses a concern that the final landscaping plans may differ from the proposed plant palettes, which primarily feature native plants. Refer to **MR-3, Use of Native Plants and Vegetation**, and Responses TCRP-12 and TCRP-13. The plant palettes included in Chapter 3 of the EIR are the palettes that were provided by the design team, and they are continuing to be used as a guide for the detailed landscaping design plans. As previously noted, native plants have been prioritized in the plant palette and considerations for historical floral communities and pollinator resources are being incorporated in the project's landscaping design plans. Refinements to the landscaping plan are continuing to be considered by the County as the design evolves. No changes to the EIR were determined to be necessary in response to this comment.

Comment No.	Response
TCRP-15	The commenter notes that they were provided information that new landscape installations would include 90 to 95% natives. While an exact percentage is not available at this time, California native plants and trees will be prioritized in the project's landscaping plan. However, for practical reasons a limited quantity of adapted species that are not native would be included in some areas of the site. It is correct that the estimates excluded the open lawn areas. However, this comment does not change the findings or conclusions in the Draft EIR; no changes to the EIR were determined to be necessary in response to this comment. Additionally, refer to **MR-3, Use of Native Plants and Vegetation**.
TCRP-16	The commenter states that the Los Angeles Climate Reality Project hopes to serve as an advisor to the project. This is not a comment on the Draft EIR; therefore, no response is necessary. The County appreciates the input that the Climate Reality Project has provided on the project to-date, and it is being considered throughout the design process. No changes to the EIR were determined to be necessary in response to this comment.

2.3.2 Los Angeles Audubon Society

Los Angeles Audubon Society
P.O. Box 931057
Los Angeles, California 90093-1057

LOS ANGELES AUDUBON

October 24, 2023

Via Email (lnegritto@nhm.org)

Leslie Negritto, Chief Operating Officer
Natural History Museums of Los Angeles County
900 Exposition Boulevard
Los Angeles, California 90007

Re: Draft Environmental Impact Report for the La Brea Tar Pits Master Plan Project (SCH # 2022020344)

Dear Ms. Negritto:

Los Angeles Audubon Society has been a voice for birds and conservation in Los Angeles for over 110 years. Our mission is to promote the study and protection of birds, other wildlife, and their habitats throughout the diverse landscapes of the Los Angeles area. We have over 3,500 members and supporters, most of whom live in the County of Los Angeles.

The La Brea Tar Pits and Page Museum are important cultural and scientific institutions that educate the public about the history of the region. The insights from the excavations and associated research are vitally important and inform much of what we know about the paleohistory of birds in this region (Allen et al. 2016). The park and museum complex is also a unique site in that it has areas that have never been developed to urban uses, including vegetation that could well be over 100 years old. **LAA-1**

Los Angeles Audubon Society offers the following comments on the Draft Environmental Impact Report (DEIR) for the Master Plan for the redevelopment of the Tar Pits portion of the park.

This project, in combination with the overdevelopment of the remainder of the site by the Los Angeles County Museum of Art, represents one more step toward the total replacement of the remaining bits of open, undeveloped space with buildings, active programming, and sterilized landscape. **LAA-2** Where will the nature persist after cutting down 200 trees? How will the ecological contiguity of land be maintained? People and wildlife need parks with fewer buildings, not more. **LAA-3**

Second, the design of the project could not be more hazardous for birds if had intentionally been designed to kill birds for the purpose of adding them to the Museum's collection. Given the ongoing, known bird mortality resulting from the construction of a large glass cube at the **LAA-4**

Museum's facility in Exposition Park in 2013, one would have imagined that the project designers would have been instructed to pursue bird-friendly building practices (Sheppard and Phillips 2015). Apparently, this did not happen. **LAA-4 (cont'd)**

The large expanses of glass that characterize the new facilities are inherently dangerous to birds. Birds cannot perceive glass as a barrier and will try to fly through these walls of glass. They also cannot distinguish reflections from reality and will collide with windows for this reason as well. **LAA-5** To make things even worse, the intention is to light these walls of glass from within at night, which will also attract birds and increase the probability of them colliding with the glass. **LAA-6** This is a similar situation, at a larger scale, to the lobbies at the Wilshire Federal Building in Westwood, where I have collected birds that were attracted to and then collided with windows in exactly the manner that they will be attracted to and die at the extension of the Page Museum. **LAA-7**

The renderings for the future design of the pathways around and over the lake depict glass barriers without any design elements that would allow birds to see them. These are especially deadly to birds because they see right through them, do not perceive them to be barriers, and collide with them. This cannot be monitored if it were constructed as currently rendered because the birds would fall right into the lake. It is extremely common for birds to fly over the surface of wetlands when foraging for insects. The failure of a Museum of Natural History to consider the very basic issue of bird-friendly building is astonishing, especially after constructing a bird-killing structure previously (the Otis Booth Pavilion; see https://www.archpaper.com/2013/09/las-natural-history-museum-addition-not-for-the-birds/). **LAA-8**

We request that the Master Plan adopt, as a mitigation, the bird collision deterrence guidelines articulated in the LEED system for new construction (see https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-data-75?return=/credits/New%20Construction/v4.1). This should apply to both the building and the glass pathway railings. It would involve using glass with fritting, etching, or other patterns to make the surfaces visible for birds, or changing the design to avoid massive expanses of glass.

The mitigation measure would also involve reducing light at night to meet the LEED SS credit for Light Pollution Reduction. **LAA-9**

Proper mitigation is necessary because millions of birds migrate over the City of Los Angeles each spring and fall and they are subject to attraction to lights and mortality (Horton et al. 2019). These birds include sensitive species and as a whole, migratory songbirds are a sensitive group, having declined precipitously since the 1970s (Rosenberg et al. 2019). Construction of the facility as depicted in the renderings would constitute an impact through disturbance of migratory pathways for migratory birds and through impacts to migrants that winter in Los Angeles, such as Yellow-rumped Warbler, Townsend's Warbler, and Hermit Thrush (Wood and Esaian 2020). These species need not be rare or endangered to merit consideration under CEQA, as was found in the recent decision regarding the environmental review for the Sidewalk Repair Program in the City of Los Angeles. CEQA requires consideration of such impacts to native wildlife and their mitigation. **LAA-10**

2

The proposed design for the park renovations do not protect wildlife habitat to the degree feasible. It would have been possible to add to the Page Museum by building up vertically, keeping the footprint of the building and allowing the park to be kept as open space instead of eaten up by additional buildings. The range of alternatives in the DEIR is impermissibly narrow in that an alternative to does not increase the footprint of the museum, which absolutely could be designed to meet all project goals, was not included in the evaluation. LAA-11

The DEIR also fails to properly identify the removal of 150-200 trees as a significant adverse impact on wildlife. Resident and migratory birds use trees and shrubs across the City of Los Angeles as habitat and the aggregate loss of trees is generally understood to be LAA-12 an adverse impact on the environment. The DEIR does not include adequate surveys for birds to be able to understand impacts, noting only "species typical of urban areas" and listing seven species. To the contrary, if one consults eBird for the Page Museum and surroundings, there is a species list of 97 native species, which one cannot construe as a typical urban location (see https://ebird.org/hotspot/L761484). The species documented at the La Brea Tar Pits / Page Museum include:

Mallard
Ring-necked Duck
Ruddy Duck
Band-tailed Pigeon
Mourning Dove
Vaux's Swift
White-throated Swift
Black-chinned Hummingbird
Anna's Hummingbird
Costa's Hummingbird
Rufous Hummingbird
Allen's Hummingbird
American Coot
Black-necked Stilt
Greater Yellowlegs
Short-billed Gull
Ring-billed Gull
Western Gull
California Gull
Herring Gull
Glaucous-winged Gull
Great Egret
Snowy Egret
Turkey Vulture
Sharp-shinned Hawk
Cooper's Hawk
Red-shouldered Hawk
Red-tailed Hawk
Western Screech-Owl
Acorn Woodpecker
Downy Woodpecker
Nuttall's Woodpecker
American Kestrel
Peregrine Falcon
Pacific-slope Flycatcher
Black Phoebe
Say's Phoebe
Ash-throated Flycatcher
Cassin's Kingbird
Western Kingbird
Plumbeous Vireo
Warbling Vireo
California Scrub-Jay
American Crow
Common Raven
Mountain Chickadee
Oak Titmouse
Northern Rough-winged Swallow
Tree Swallow
Violet-green Swallow
Barn Swallow
Bushtit
Wrentit
Ruby-crowned Kinglet
Red-breasted Nuthatch
White-breasted Nuthatch
House Wren
Bewick's Wren
Northern Mockingbird
Western Bluebird
Mountain Bluebird
Hermit Thrush
American Robin
Cedar Waxwing
Phainopepla
House Finch
Purple Finch
Pine Siskin
Lesser Goldfinch
American Goldfinch
Chipping Sparrow
Lark Sparrow
Fox Sparrow
Dark-eyed Junco
White-crowned Sparrow
Savannah Sparrow
Song Sparrow
Lincoln's Sparrow
California Towhee
Spotted Towhee
Hooded Oriole
Bullock's Oriole
Red-winged Blackbird
Brown-headed Cowbird
Brewer's Blackbird
Great-tailed Grackle
Orange-crowned Warbler
Nashville Warbler
Common Yellowthroat
Yellow Warbler
Yellow-rumped Warbler
Black-throated Gray Warbler

LAA-13

3

Townsend's Warbler	Wilson's Warbler
Hermit Warbler	Lazuli Bunting

LAA-13 (cont'd)

This list includes sensitive species, species in decline, and indicator species of the oak woodlands and wetland habitats found at the site. The DEIR is currently inadequate in its assessment of its impacts on birds and should find that the removal of 150 to 200 trees is a significant adverse impact on the bird community at this site. Simple replacement of trees would be an inadequate mitigation measure because the design reduces the habitat area for birds considerably and species number is closely tied to habitat area (Preston 1948). It is simple mathematics to see that more area converted to building and sterile turfgrass will reduce the bird diversity in the park, which should be recognized and mitigated.

LAA-14

LAA-15

The DEIR fails to report on the presence of bat species at the project site, when they are almost certainly present, especially foraging over the pond. One of the region's bat experts works at the Natural History Museum, so it would be beneficial if he had been consulted. There is literally an announcement on the Museum's website that bats still fly over the Tar Pits as of 2014 and this information did not make it into the DEIR (see https://nhm.org/stories/we-found-bats-living-la-brea-tar-pits). The story on the Museum's own website reports that the Tar Pits support *four* bat species — big brown bat (*Eptesicus fuscus*), canyon bat (*Parastrellus hesperus*), Mexican free-tailed bat (*Tadarida brasiliensis*), and Yuma myotis (*Myotis yumanensis*). Yuma myotis is a sensitive species recognized by the State of California (see https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=2349).

LAA-16

There is no reason to think that these species are not still present. How will construction and tree removal affect these species? The DEIR does not even consider the possibility that bats might be present. How will lighting from the project, which will be extensive, affect these species? Bats are known to be sensitive to lighting impacts (see Voigt et al. 2018). The DEIR fails as an informational document in that it does not identify the presence of bat species, including one sensitive species. It further fails in not evaluating the impacts of a large construction project, cutting down hundreds of trees, and installation of extensive new lighting on the bat species.

LAA-17

Los Angeles Audubon Society is available to work with the Natural History Musuems of Los Angeles County to reduce the significant adverse impacts on local wildlife represented by this proposal.

LAA-18

Sincerely,

Travis Longcore, Ph.D.
President

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LEED BD+C: New Construction v4.1 - LEED v4.1

Innovation: Bird Collision Deterrence

Innovation catalog

Possible 1 Points

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Intent

Reduce bird injury and mortality from in-flight collisions with buildings.

Requirements

For all exterior lighting, meet uplight and light trespass requirements in the LEED SS credit Light Pollution Reduction. Emergency lighting and government-mandated lighting are exempt from this requirement.

AND

Comply with the “Building façade and site structures,” requirements below.

Building façade and site structures

Develop a building façade and site design strategy to make the building and site structures visible as physical barriers to birds. For the purposes of this credit, “bird-friendly materials” include glazing that incorporates physical signals to birds created by fritting and UV coatings; non-glazing, opaque and non-reflective materials such as concrete; glazing behind qualifying sunshades and screens; glazing to which materials such as qualifying window films have been applied. Refer to ABC’s Threat Factor Database for a list of qualifying materials (https://abcbirds.org/glass-collisions/products-database/?_product_interest=professionals). LAA-19

If all materials on the building façade have a Threat Factor of 30 or below, the project is exempt from the building façade requirements. Otherwise, use the instructions below to calculate the Bird Collision Rating.

All other structures on the site, including, but not limited to handrails, guardrails, windscreens, noise barriers, gazebos, pool safety fencing, bus shelters, band shells, etc. must be constructed entirely of materials with a threat score value of 30 or less.

Steps for calculating the Bird Collision Rating (BCR)

First separate each building facade into Façade Zone 1 and Façade Zone 2. Façade Zone 1 includes the first 40 feet above grade, measured from grade at all points, as well as 12 feet above any green roof. Façade Zone 2 includes all façade areas between 40-100 feet. Establish total areas for Façade Zone 1, Façade Zone 2 and for the Adjusted Building Façade Area. Then identify the Material Types present on each façade, the corresponding Threat Factor of each material (for detailed types and associated threat factors, see the Threat Factor table developed by the American Bird Conservancy https://abcbirds.org/glass-collisions/products-database/?_product_interest=professionals), and the total area of each Material Type.

No more than 5% of the facade area in Façade Zone 1 can have a Threat Factor higher than 30. This area is quantified separately as the High Risk Factor (HRF) in the calculator. However, more than 5% of the glazed area in Zone 2 may have a Factor higher than 30. All glazed corners or fly-through conditions must have a Threat Factor less than or equal to 30.

Help

Table 1: General material types: threat potential

	Material Type
Greatest Threat Potential	Glass: Highly reflective and/ or completely transparent surface
Less Threat Potential	Glass: Reflective or transparent surface interrupted by a visible pattern or shielded by screens, shutters, or louvers where the resultant exposed glass satisfies the 2 x 2 Rule*.
Least Threat Potential	Glass: Translucent with matte or textured surface
No Threat	Opaque, non-reflective surface

*The 2 x 2 Rule is defined as a collision deterrence module based upon the physical profile of a bird in flight. Current research has established maximum module dimensions of 2" high x 2" wide for effective visual markers.

Using the formulas below, achieve a maximum total building Bird Collision Rating (BCR) of 15 or less. The Bird Collision Rating Calculation Spreadsheet can also be used. The total area of glass with a Threat Factor > 30 must be distributed across the building envelope in proportion to the façades.

For each Façade Zone, calculate the Factored Area: [(Material Type 1 Threat Factor) x (Material Type Area)] + [(Material Type 2 Threat Factor) x (Material Type Area)]... = Façade Zone Factored Area

Determine the Adjusted Building Façade Area: [(2 x Zone 1 Area) + Zone 2 Area] = Adjusted Building Façade Area

Calculate the total building Bird Collision Rating by dividing the sum of Zone 1 and Zone 2 Factored Areas by the Adjusted Building Façade Area: (Zone 1 Factored Area + Zone 2 Factored Area) / Adjusted Building Façade Area = Total Building BCTR

LAA-19 (cont'd)

General Documentation Requirements

Building façade and site features

- A completed Bird Collision Rating spreadsheet (if materials have a Threat Factor above 30).
- Plan(s) and/or elevation(s) depicting the location of all materials and shading/screening devices used to comply with this credit.
- Applicable specification details on all materials and shading/screening devices used to comply with this credit. If a chosen material does not have a Threat Factor value, provide an estimated value with justification.

Exterior lighting Submit the following:

- Exterior site lighting plan with boundaries, elements, location of fixtures, lighting zone, and applicable measurements
- Exterior luminaire schedule showing uplight ratings, nighttime off-time durations for a typical day, and manual override capability

NATURAL HISTORY MUSEUM LOS ANGELES COUNTY

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Stories | **We Found Bats Living at La Brea Tar Pits!**

(D BE ADVISED: On Saturday 10/28, the museum will close at 2 PM in preparation for a large event, with some areas closing to the public at noon. Boney Island at NHM will be open to the public at 8 PM. Please Q@JJ i'Our visit accordingly. For more information or to reschedule your visit, email l.ofu_@_o.b.D1Qrg or cal 213.763.DINO

LAA-19 (cont'd)

We Found Bats Living at La Brea Tar Pits!

We've recently discovered that bats are still flying over the Tar Pits on a regular basis!

By: Miguel Ordeiiana Share: f 't#

Miguel Ordenana hanging out with a pallid bat *(Antrozous pallidus)-one* of only two species of bats recovered from the prehistoric Tar Pits-during field work.

Published October 9, *2014*

LAA-19
(cont'd)

nhm.org

We Found Bats Living at La Brea Tar Pits!

4–5 minutes

Published October 9, 2014

If you've ever been to La Brea Tar Pits you might have wondered if bats were around during the last Ice Age when saber-toothed cats (*Smilodon fatalis*), Columbian mammoths (*Mammuthus columbi*), and dire wolves (*Canis dirus*) roamed the land that is now our city. Well, we're happy to tell you that the answer is yes, and we've recently discovered that bats are still flying over the Tar Pits on a regular basis!

But how do we know that bats are still living in the Miracle Mile? It's all thanks to bat detectors. Bat detectors are devices myself and other scientists use to record the ultrasonic calls—remember echolocation from biology class—that bats use to communicate, hunt, and find their way around in the dark. I then use special computer programs that turn the calls into sonograms so I can visualize the call. Because each bat species' call is distinct, I can then tell which bats have been flying near my detector. **LAA-19 (cont'd)**

Here are some sonograms of bats I detected at the L.A. Zoo: Pictured top is the canyon bat (*Parastrellus hesperus*), and below is the Western mastiff (*Eumops perotis*).

In early July, I set up a bat detector along the shore of the big lake at the Tar Pits. I knew the site seemed like great bat habitat because it has a body of water which helps to support insects (a.k.a. bat food), and there are lots of trees for bats to roost in. However, this still felt like a big gamble to me. There are no bat specimens from the Tar Pits or Hancock Park in the museum's Mammalogy collection, and this is really expensive gear.

LAA-19
(cont'd)

But after communicating with our paleontologists that work at the George C. Page Museum, I learned that bats did in fact use the area during the last Ice Age. Research conducted by Bill Akersten (former curator at the Page Museum) in the late 1970s found that unlike the hundreds of dire wolves that have been found at the Tar Pits, bat fossils were rarely recovered because they are fragile and small. Only two bat species have been confirmed at the Tar Pits, the pallid bat (*Antrozous pallidus*), and the hoary bat (*Lasiurus cinereus*). Although the environment has gone through dramatic changes since then, I find it remarkable that these two species still live in our region. But how many bats call the Tar Pits home today?

Just two months after I installed our bat detector in July 2014, we have discovered four species of bats at the Tar Pits! The detector has recorded the following species big brown bat (*Eptesicus fuscus*), canyon bat (Parastrellus hesperus), Mexican free-tailed bat (*Tadarida brasiliensis*), and Yuma myotis (*Myotis yumanensis*). I don't find it that surprising that we didn't record the pallid or hoary bat as these species are more sensitive to urbanization.

However, I'm hopeful that the gardens we've been planting at both the Tar Pits, and the Nature Gardens at NHM will provide good habitat for more species of bats.

Case in point—in September 2013, the museum's Mammalogy Collections Manager, Jim Dines, and I set up a bat detector in the museum's Nature Gardens. Over the last year, we've recorded four species of bats in the gardens. If you want to hear that story, you'll have to wait until later this month during National Bat Week! So turn your echolocation on and stay tuned, and in the meantime take a moment to think about the bats that fly over the Tar Pits and your neighborhood nightly, and what life would have been like for bats, birds, and bees in the Ice Age!

LAA-19
(cont'd)

Ecological Applications, 30(7), 2020, e02149

The importance of street trees to urban avifauna

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Abstract. Street trees are public resources planted in a municipality's right-of-way and are a considerable component of urban forests throughout the world. Street trees provide numerous benefits to people. However, many metropolitan areas have a poor understanding of the value of street trees to wildlife, which presents a gap in our knowledge of conservation in urban ecosystems. Greater Los Angeles (LA) is a global city harboring one of the most diverse and extensive urban forests on the planet. The vast majority of the urban forest is nonnative in geographic origin, planted throughout LA following the influx of irrigated water in the early 1900s. In addition to its extensive urban forest, LA is home to a high diversity of birds, which utilize the metropolis throughout the annual cycle. The cover of the urban forest, and likely street trees, varies dramatically across a socioeconomic gradient. However, it is unknown how this variability influences avian communities. To understand the importance of street trees to urban avifauna, we documented foraging behavior by birds on native and nonnative street trees across a socioeconomic gradient throughout LA. Affluent communities harbored a unique composition of street trees, including denser and larger trees than lower-income communities, which in turn, attracted nearly five times the density of feeding birds. Foraging birds strongly preferred two native street-tree species as feeding substrates, the coast live oak (*Quercus agrifolia*) and the California sycamore (*Platanus racemosa*), and a handful of nonnative tree species, including the Chinese elm (*Ulmus parvifolia*), the carrotwood (*Cupaniopsis anacardioides*), and the southern live oak (*Quercus virginiana*), in greater proportion than their availability throughout the cityscape (two to three times their availability). Eighty-three percent of street-tree species ($n = 108$, total) were used in a lower proportion than their availability by feeding birds, and nearly all were nonnative in origin. Our findings highlight the positive influence of street trees on urban avifauna. In particular, our results suggest that improved street-tree management in lower-income communities would likely positively benefit birds. Further, our study provides support for the high value of native street-tree species and select nonnative species as important habitat for feeding birds.

Key words: bird; California; foraging behavior; Los Angeles; migratory; native vegetation; nonnative vegetation; socioeconomic; urban forest; wildlife.

Introduction

Urbanization, the process of converting a natural ecosystem to one dominated by human development, is one of the most pervasive and dominant forms of land use globally (Foley et al. 2005, Grimm et al. 2015). Urbanization is a crucial process for providing living and working conditions for humans. However, the radical transformation of the landscape, coupled with the excessive requirements of cities for resources from outside their boundaries, has profound and negative impacts on ecosystems (Rees 1992, Collins et al. 2003). The pace of urbanization has greatly intensified worldwide over the past half century, with cities from around the world experiencing explosive densification and growth (Grimm et al. 2015). There is no slowdown in sight as countries and cities modernize and continue to provide amenities attractive for human habitation and relocation (Angel et al. 2011, Seto et al. 2012). Thus, the ecological footprints of urban areas will likely continue to grow, which poses critical challenges for biodiversity conservation (McKinney 2002, Lepczyk et al. 2017a).

The United States illustrates an example of a country that has undergone rapid urbanization, where, following the industrial revolution, cities have sprung up and sprawled, consuming much of the rural landscape (Angel et al. 2011, Grimm et al. 2015). One U.S. city in particular that exemplifies this pattern of growth is Los Angeles, California. Since the late 1800s, Los Angeles has grown from sparse homesteads and ranches situated across dusty agricultural fields to a major global metropolis (Stein et al. 2007). With the diversion of water from

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LAA-19
(cont'd)

the Owens Valley in the early 20th century, Los Angeles boomed with people from across the United States and world moving to the California southland (Reisner 1987). A notable trend during the growth period in the early part of the 20th century and post-WWII was the settlement of the region by residents from the American Midwest and Northeast (Pierson Doti and Schweikart 1989). Stately homes and neighborhoods with lawns and lush vegetation were developed, and city planners designed tree-lined streets similar to what you would find in more mesic urban areas (Reisner 1987). Given the mild climate, the abundance of water from afar, and wealth, city planners created one of the most diverse and extensive urban forests in the world. We define "urban forest" as a collection of all trees within the boundaries of a metropolitan area (Nowak 2016). Estimates suggest there are well over a hundred tree species, with most being nonnative in geographic origin, planted throughout the entirety of Los Angeles (Clarke et al. 2013, Avolio et al. 2015).

One distinct component of urban forests throughout the world, including Los Angeles, are street trees (McPherson et al. 2016). Street trees are public resources and are therefore planted by municipalities in rights-of-way (e.g., sidewalk strips, Fig. 1; City Plants 2019). Street trees are planted for a variety of reasons and provide numerous functional services that benefit urban residents (McPherson et al. 2016). For example, street trees improve the aesthetical quality of cities (Southworth 2005), provide valuable environmental benefits (Livesley et al. 2016), and are positively associated with improved quality of life (Nowak et al., 2010). Further, street trees provide habitat for animals (Bhullar and Majer 2000, Shackleton 2016, Gray and van Heezik 2016) and thus likely provide a valuable role in urban biodiversity conservation (Nowak et al. 2010). Due to their importance, many cities have well-developed street-tree plans (City of Los Angeles 2004) and work to promote, maintain, and provide an inventory of trees within a city's boundary (McPhearson et al. 2010, 2011).

Street trees are prevalent throughout cities in California, accounting for approximately 10–20% of the trees within the state's urban forests (McPherson et al. 2015). Despite their commonness, the maintenance costs of street trees are likely high due to the excessive need for water to encourage growth in the arid environment (City Plants 2019). Further, while street trees are public resources, it is typically the responsibility of the property owner to maintain a tree adjacent to a residential unit (City Plants 2019). Because of the cost associated with maintaining street trees, lower-income communities in some cities harbor a lower density of street trees and less urban forest cover than affluent communities (Landry and Chakraborty 2009, Kuruneri-Chitepo and Shackleton 2011, Schroeter 2017). We define "street-tree density" as the total number of street trees over a given area (Nowak et al. 2001), and "urban forest cover" as the area covered by the tree canopy throughout an urban

Fig. 1. Street trees in a suburban neighborhood in Los Angeles County, California, USA (Photo credit, E. Wood).

ecosystem (Walton et al. 2008). One hypothesis put forth to explain the disparity in urban forest cover along a socioeconomic gradient is the "luxury-effect hypothesis" (Leong et al. 2018), also termed the "inequity hypothesis" (Landry and Chakraborty 2009), which states that wealthy neighborhoods can withstand the financial costs of maintaining and caring for public and private trees while impoverished neighborhoods cannot. The luxury-effect pattern is consistent across many cities in the world in explaining urban forest cover (Schwarz et al. 2015, Aronson et al. 2017, Avolio et al. 2018, Leong et al. 2018).

Further, there is additional support for the luxury effect extending to street trees (Brooks et al. 2016). Illustrating this, in Tampa Bay, Florida, and New York City, New York, lower-income communities harbored less street-tree cover than affluent areas (Landry and Chakraborty 2009, Schroeter 2017). In the Eastern Cape of South Africa, street-tree diversity was higher in wealthy suburbs (Kuruneri-Chitepo and Shackleton 2011). While it is clear that patterns in urban forest and street-tree cover differ sharply across a socioeconomic gradient in many cities, it is unknown whether any apparent variability in street-tree composition, density, and size influences urban bird communities.

LAA-19 (cont'd)

Los Angeles is home to a high diversity and abundance of birds (Higgins et al. 2019), which consists of hundreds of migratory and non-migratory species that utilize the urban ecosystem throughout the annual cycle (Garrett et al. 2012). One component of Los Angeles' avian community that is prevalent during the winter months are migratory forest-breeding birds (e.g., Yellow-rumped Warbler, *Setophaga coronata*), which spend upward of six months of the annual cycle feeding on tree and shrub surfaces as they prepare for the spring migration and summer breeding season (Garrett et al. 2012). The other dominant component of the southern California avian community are non-migratory birds, which are species that reside in natural habitats, such as chaparral, or urban environments throughout the year (Garrett et al. 2012, Higgins et al. 2019). While birds are seemingly ubiquitous throughout Los Angeles, their ecology in the urban ecosystem remains poorly understood, including their use of street trees. Providing wildlife habitat is a goal of many urban forest plans (Nowak and Dwyer 2000). However, there is no comprehensive assessment for the value of street trees to urban biodiversity in Los Angeles, or likely most cities around the world, which presents a critical gap in our understanding of conservation in urban ecosystems.

To understand the importance of street trees to wildlife, we designed a study where we measured and identified public street trees and documented foraging behavior of birds across two winters in residential communities situated across a socioeconomic gradient throughout Greater Los Angeles (hereafter LA). LA is an optimal place for studying the ecology of birds and street trees primarily because of the sheer extent and diversity of street trees within the urban forest as well as the stark differences in canopy cover throughout the metropolitan area. Further, birds are an optimal group for studying the importance of street trees to wildlife primarily because of their abundance and ability to reach nearly all areas of the urban ecosystem.

We had three objectives for our study. First, we documented patterns of street-tree composition, diversity, density, and size, as well as feeding bird composition, diversity, and density across a socioeconomic gradient. We predicted that there would be distinct street-tree communities across the socioeconomic gradient, with higher diversity and size of trees in more affluent areas, which is in line with the luxury-effect hypothesis (Landry and Chakraborty 2009, Kuruneri-Chitepo and Shackleton 2011, Brooks et al. 2016, Schroeter 2017). Further, we predicted that there would be distinct avian communities as well as more feeding birds in affluent areas, in part because of expected patterns of bird abundance in urban areas with higher vegetation cover (Blair 1996). Second, we quantified relationships between street-tree diversity, density, and size and feeding bird density. We predicted that feeding birds would be positively related to greater street-tree diversity, density, and size, primarily because of associations between birds and large and dense tree canopies in urban environments (DeGraaf and Wentworth 1986). Third, we evaluated whether there were patterns in foraging preferences of birds between native and nonnative street-tree species. We predicted that birds would prefer native rather than nonnative trees, as native vegetation in urban environments provides abundant food resources for birds (Narango et al. 2017).

Methods

Study area

We collected data on street-tree diversity, density, size, and avian foraging behavior across a socioeconomic gradient in 36 residential communities throughout LA (Fig. 2a). The LA County metropolitan area is a sprawling mosaic of large and medium-sized cities (e.g., Los Angeles, Long Beach, and Pasadena) and smaller municipalities (e.g., Culver City, Cerritos, and Montebello) that covers over 12,000 km^2 and has a population of over 10,000,000 people (U.S. Census Bureau 2019; Fig. 2a). Mountainous protected areas ring the metropolis on the northern and eastern fringes, and the Pacific Ocean forms the southern and western boundary. The climate of the region is Mediterranean, characterized by cool, wet winters and hot, dry summers. The growing period typically follows the winter rains, and the native vegetation of the valley bottoms, which have been nearly fully developed, is a mosaic of wetland, grassland, shrubland, and woodland environments (Stein et al. 2007). Vegetation in the urbanized areas experiences variable growing conditions throughout the year, depending on irrigation patterns, planting practices, and geographic position in the city. For example, there are over 1,000 species of nonnative plants throughout LA (Avolio et al. 2019), and each likely has unique phenological patterns that may influence bird-feeding behavior (Appendix S1). Patterns of precipitation and temperature are also highly variable throughout the region (yearly averages: 19°C/ 13°C high and low temperatures and 379 mm precipitation). In general, coastal communities have temperatures and precipitation patterns that are more moderate, whereas valley and mountain areas experience more extreme temperature ranges and periodic heavy precipitation that occasionally cause flooding in valleys.

The settlement history of LA created one of the most diverse and multicultural metropolises in the world (Pierson Doti and Schweikart 1989, Evanosky and Kos 2014). In addition to the multiculturalism of LA, the city contains a great range of wealth distribution (Fig. 2). Municipalities such as Beverly Hills and San Marino typify extreme opulence, whereas areas such as downtown LA's skid row and communities in southcentral LA experience poverty, based on the U.S. Census poverty thresholds for a family of four in 2015 (<US$24,257, U.S. Census Bureau poverty thresholds, Fig. 2). The patterns of tree cover throughout LA reflect patterns of the

LAA-19
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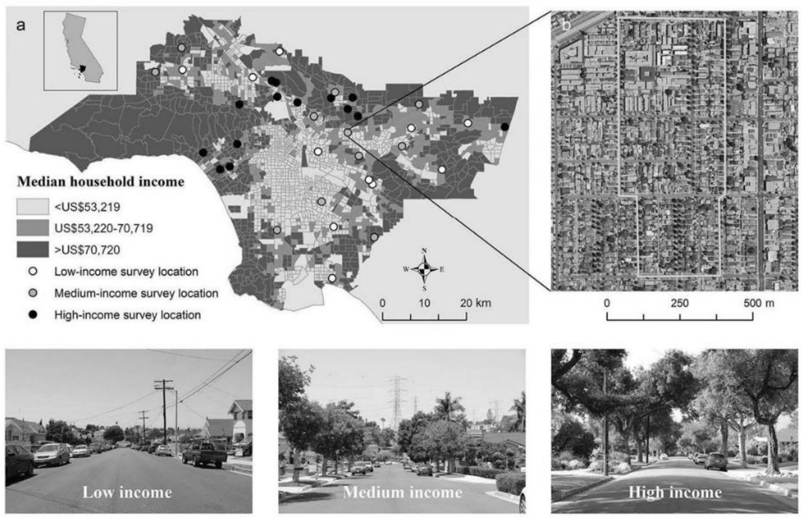

FIG. 2. (a) Sampling design depicting 36 survey locations distributed across a socioeconomic gradient throughout the Los Angeles basin and surrounding valleys and mountains, Los Angeles County, California. (b) Inset map highlights a walking route (yellow line), where observers documented bird-feeding behavior in street trees, twice during each of the 2016–2017 and 2017–2018 winter seasons. Further, observers identified, recorded location, and measured diameter at breast height for all street trees throughout each route. Photos highlight typical differences in street trees from low-, to medium-, to high-income areas of Greater Los Angeles (Photo credits, E. Wood).

income distribution, where lower-income communities have far less "tree" cover than affluent ones (Avolio et al. 2015, Fig. 2). The spatial distribution of wealth follows a pattern where affluent communities tend to be located in the foothills of mountainous protected areas and open spaces, the immediate coastal zones, and the southeastern border with Orange County (Fig. 2a). In contrast, lower-income communities are located surrounding downtown LA, East LA, southcentral LA, and central portions of the San Fernando Valley (Fig. 2a).

To address our study objectives, we established a survey design set in residential communities throughout LA. To identify residential communities along a socioeconomic gradient of survey interest, we used U.S. census tract data, combined with published records of median household income (Los Angeles Times 2015). To determine low-, medium-, and high-income census tracts, we gathered median household income values, tabulated by the 2010 census, for 265 neighborhoods that were located within our study boundaries of Los Angeles County (Los Angeles Times 2015; Fig. 2a). The median household income based on the 2010 U.S. Census tract data was US$62,932, which was comparable to the U.S. Department of Housing and Urban Development (2015) median family income calculations for 2015 in Los Angeles County (US$63,000, data available online).[4] From the 2010 U.S. Census tract data, we determined the lower 33% as "low" (<US$53,219), the middle 33% as "medium" (US$53,220 to US$70,719), and the upper 33% as "high" (>US$70,720). We initially considered 2163 census tracts for inclusion in our sampling design. One thousand and eighty one census tracts were in low-income communities (49.98% of the total), 470 in medium-income communities (21.73%), and 612 in high-income communities (28.29%, Fig. 2). Low-income census blocks covered approximately 25% of the available area for study, whereas medium- and high-income communities covered 19% and 56% of the available area for study, respectively (Fig. 2).

After categorizing census tracts based on socioeconomic levels, we used a spatially balanced random-tessellation approach (Stevens and Olsen 2004) in conjunction with ArcGIS software (ESRI 2016) to identify 60 census tracts with 20 in each of low-, medium-, and high-income brackets. We then used Google Earth combined with Google Street View (Google 2016) to identify residential areas within selected census tracts with streets bordered by sidewalks that separated private

[4] https://www.huduser.gov/portal/home.html

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front yards from street trees (Fig. 1). Some sections of LA, especially more affluent regions, lacked sidewalks, and we excluded those from our survey for safety precautions and because of the ambiguity over whether trees were considered public (i.e., a street tree) or private (i.e., a tree in a yard) due to no noticeable right-of-way separating private yards from streets. Further, we avoided streets with no discernable zone for street trees, areas where surveys were challenging due to pedestrian and vehicle traffic (e.g., major thoroughfare roads, freeway on/off ramps, commercial zones, and industrial areas), public spaces that were not residential (e.g., city parks), and sections of the city where safety was a concern. After further scrutiny of the 60 identified census tracts, we refined our initial selection based on our sampling requirements, leaving us with 36 survey locations, with 12 located in each of low-, medium-, and high-income census tracts. Within each of the 36 survey locations, we plotted walking routes using Google Earth software (Google 2016) that were approximately two and a half km in length (average, 2.49 km), which we used for all street-tree sampling and bird-foraging behavioral work (Fig. 2b). The boundary surrounding the extent of our survey locations encompassed an area of approximately 4,395 km^2 and included the foothills of major mountain ranges, the main valleys of LA, including the LA Basin, the San Fernando Valley, and the San Gabriel Valley, and the western portions of the Inland Empire (Fig. 2). The distance between the centroids of survey locations ranged from 1.08 to 12.67 km, with an average length of 5.10 km (Fig. 2). Our sampling design yielded independent data, which was necessary for statistical analyses (Appendix S1, Fig. S1).

Duc to thc rapidly shifting housing markct in LA and our selection of routes that contained street trees and other amenities such as sidewalks that are likely associated with increased housing value, it was apparent that we misclassified some survey locations based on the 2010 census data. Thus, before our analysis, we further refined our socioeconomic classifications based on estimated housing values from the Redfin real estate website (Redfin 2018). During the fall of 2018, we gathered estimated real estate values for all single-unit homes, as well as values for single units within multi-unit residences (e.g., apartment complex) with frontage property on walking routes (n = 6,292) and calculated the range (US $59,000–US$26,100,000), the median (US$677,000), and the lower (<US$593,000 USD) and upper-third (>US $809,000 USD) percentiles. Further, we gathered data on the parcel size and the number of all single-unit residences on walking routes. We calculated the range (parcel size, 155.61–5053.83 m^2; single-unit homes per 1 km of walking route, 36–130), the median (parcel size, 668.81 m^2; single-unit homes per 1 km of walking route, 59), and the lower (parcel size <609.91; single-unit homes per 1 km of walking route, <51) and upper-third (parcel size >703.36; single-unit homes per 1 km of walking route, >65) percentiles. From the updated real estate values, we shifted one low-income neighborhood to medium income, and two medium-income neighborhoods to high income, leaving us with 11 survey locations in low-, 11 in medium-, and 14 in high-income residential areas (Fig. 2).

Public street-tree measurements

We measured diameter-at-breast-height (DBH) and recorded the tree species for each street tree along a walking route. To quantify street-tree species availability as foraging substrates for birds, we calculated density, dominance, and the importance value of each tree species (Holmes and Robinson 1981, Gabbe et al. 2002, Wood et al. 2012). DBH is a strong predictor of tree crown diameter and height in both forest (Gering and May 1995) and street-tree populations (Peper et al. 2001), and thus, we assumed is a surrogate for quantifying the availability of foraging substrate for arboreal feeding birds in our urban study system. Density represents the total number of a given tree species over a defined area, whereas dominance is a measure of the area covered by a street-tree species. To calculate dominance, we converted DBH values of a measured tree into a basal area (Gabbe et al. 2002, Wood et al. 2012). We standardized the total counts of trees and basal area to 1-km of walking route, which enabled us to calculate total tree density and total basal area in each survey location. We used the standardized total tree density and total tree basal area measurements of each survey location as independent variables in our objective one and two analyses. To calculate importance values for each tree species across all survey locations, we calculated the density and basal area for each street-tree species, computed the relative values of both, and summed those to obtain importance values. We then divided the summed importance value by two to express the importance values as relative values (Gabbe et al. 2002, Wood et al. 2012). We used the relative importance values of street trees in our objective three statistical analyses. We did not include frequency in our calculation of street-tree importance values as our survey was not based on plotless sampling within forest stands, which is necessary for calculating the frequency metric (Wood et al. 2012). Further, omitting frequency and instead focusing on density and size (dominance) of street trees, two variables that we predicted would influence feeding bird behavior (DeGraaf and Wentworth 1986), is an approach that has been employed by previous investigations of importance values of street-tree populations in urban systems (McPherson and Rowntree 1989).

Avian foraging observations

To characterize the foraging behavior of birds, we surveyed all street trees along walking routes for feeding birds, twice per winter, from October to March 2016–2017 and 2017–2018. We focused our surveys during the

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winter months to observe the diverse and abundant wintering migratory bird community (hereafter migratory birds). We conducted foraging observations 30 minutes following sunrise and ended within 4 h post-sunrise. Wintering birds tend to flock and move in search of food during the non-breeding period (Greenberg 2000). Therefore, we waited at least three weeks between visits within a season to allow for any possible turnover of birds that may have immigrated to or emigrated from a survey location to limit possible double counting of individual birds during repeat visits. Our protocol called for two observers to complete surveys, with one observer walking along one sidewalk on a street, and the other on the adjacent sidewalk, moving in concert throughout the survey. S. Esaian led all field surveys and was accompanied by E. Wood or trained student observers.

To quantify migratory bird-foraging behavior on public street trees, we selected five, primarily arboreal feeding, migratory species that are common during the winter months in the LA urban forest. These included the Ruby-crowned Kinglet (*Regulus calendula*), the Orange-crowned Warbler (*Oreothlypis celata*), the Yellow-rumped Warbler (*Setophaga coronata*), the Black-throated Gray Warbler (*Setophaga nigrescens*), and the Townsend's Warbler (*Setophaga townsendi*) (Appendix S1: Table S1). We selected these species because they represent a segment of the population of terrestrial Nearctic-Neotropical migratory birds that spend the winter in southern California, they breed in more northern forested ecosystems during the summer, and they frequently forage on tree surfaces and thus were commonly encountered during our surveys (Garrett et al. 2012). Additionally, their populations are generally in decline, highlighting the importance of understanding the role of street trees in urban forests for the conservation of migratory birds (Sauer et al. 2017).

When we detected one of the five migratory bird species actively feeding on the surface of a street tree, we recorded foraging behaviors for up to three minutes (average time = 47 s). Each observation included documenting the tree species along with the bird's foraging behavior, including all search efforts (walk and shuffles, hops, and flights) and attacks (a glean on the surface of leaves, bark, flowers, or seeds, or aerial maneuver; Remsen and Robinson 1990, Wood et al. 2012). To prevent pseudo-replication of foraging observations, we recorded feeding behavior only of individuals of the same species >100 m from where we ceased a previous observation unless there were apparent differences between male and female individuals. Our methodology to avoid pseudo-replication may have masked our ability to detect more feeding birds in areas with higher tree density. Nevertheless, we decided on our approach to prevent the double counting of bird observations as we walked along routes. We frequently observed individual migratory birds foraging in multiple street trees during observations. We recorded each new tree species in which we documented a bird feeding. A handful of tree species provided challenging conditions for observing foraging birds due to their dense canopy (e.g., the Canary Island pine [*Pinus canariensis*]). If a tree canopy was overly dense, and we detected a study bird, we observed the individual until we recorded a feeding observation, which was a documentation of "use". We then ceased the observation. If we did not detect a bird feeding after three minutes in challenging-to-observe trees, we resumed our survey of other trees along the walking route. The latter scenario occurred for < 1% of our total observations.

To understand patterns of street-tree use by a segment of the bird population that is prevalent in LA throughout the annual cycle, we focused on five species that regularly forage in trees. These included the Allen's Hummingbird (*Selasphorus sasin*), the Anna's Hummingbird (*Calypte anna*), the Bushtit (*Psaltriparus minimus*), the Lesser Goldfinch (*Spinus psaltria*), and the House Finch (*Haemorhous mexicanus*) (Appendix S1: Table S2). Segments of Allen's and Anna's Hummingbird populations migrate northward during the breeding season (Garrett et al. 2012, Greig et al. 2017). However, these two species are common in LA throughout the year (Allen et al. 2016, Clark 2017). The other three species are non-migratory. Therefore, we refer to this group as "year-round" birds.

In addition to feeding on the surfaces of trees, we selected these five year-round species as each has preferences for unique food resources that were present throughout the survey period. For example, the hummingbirds are often attracted to exuberant flowering, Bushtits to leaf surfaces, and the finch species to seeds (Allen et al. 2016). Therefore, studying these five species enabled us to understand how birds with different feeding behaviors and food needs interact with the high diversity of street trees and shifting phenophases throughout the winter season (Appendix S1). When we detected a year-round species feeding on a street tree, we again recorded use and the specific substrate in which we observed a feeding attempt (e.g., leaf, bark, flower, seed, or aerial maneuver). We did not collect detailed foraging behavior on year-round birds, because their foraging behavior was often stationary (e.g., a House Finch feeding on a seed capsule of an American Sweetgum, *Liquidambar styraciflua*). Similar to our observations of migratory birds, to prevent double counting of year-round birds, we collected foraging observations only of individuals of the same species >100 m from the last observation unless it was clear they were different individuals (e.g., visual differences between male and female House Finches).

We expected that additional factors other than the street tree in which we observed a feeding bird might influence foraging behavior. For example, affluent areas often have decadent yards, full of vegetation, which may attract feeding birds (Lerman and Warren 2011, Clarke et al. 2013). Additionally, some residential communities are near protected areas or open spaces and thus could provide easier access for birds that prefer more natural

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environments (Donnelly and Marzluff 2004). In a parallel study, we counted birds throughout LA and documented whether we observed birds using either public features, which included street trees or utility lines, or vegetation in private yards (E. M. Wood and S. Esaian, *unpublished data*). Further, in that study, we recorded distance from survey locations (centroid of survey routes) to the nearest federal protected area or open space. We observed 50.1% of detected birds ($n = 3,691$) in street trees (either feeding, vocalizing, or resting) or utility lines (primarily species of *Columbidae*), whereas the other 49.9% of observations ($n = 3,679$) were in private yards, flying over count locations, or in areas where we could not determine their usage (e.g., singing from an adjacent street). While we commonly observed birds maneuvering back and forth between vegetation in yards and street trees, it was equally as common to observe birds moving from street-tree to street tree as they fed. In low-income communities, nearly all feeding birds that we detected were foraging in street trees, as there is little yard vegetation (Fig. 2). Last, we found no correlations between the density of feeding birds and street-tree density and size with distance to protected area or open space (Spearman's rho, $\rho = 0.01–0.27$, $P = 0.10–0.94$). Therefore, we assumed that our study design and survey methodology likely characterized the foraging behavior of birds based on their ecology with a given street-tree species as opposed to external factors that may have influenced their feeding patterns.

Statistical analysis

To address our first objective of documenting patterns of street-tree composition, diversity, density, and size, as well as feeding bird composition, diversity, and density across the socioeconomic gradient, we completed two separate analyses for both trees and birds, respectively. First, to identify the degree of dissimilarity in street-tree communities across the socioeconomic gradient, we conducted a one-way analysis of similarities test (ANOSIM; Oksanen 2019), using the Bray-Curtis dissimilarity of the square-root transform of counts of street trees, grouped by socioeconomic classification. The ANOSIM analysis is a nonparametric test that uses Monte Carlo randomization of observed data to assess whether ranked dissimilarities within socioeconomic groups were more similar than among groups (Oksanen 2019). We used 999 Monte Carlo permutations to generate the random test statistic, R, which ranges from −1 to 1. An R value near zero indicates that the street-tree community does not differ among socioeconomic groups, whereas R values further from zero indicate increasing dissimilarity. As we made three comparisons among the three socioeconomic groups, we used a Bonferroni adjustment to the alpha value of $0.05/3 = 0.017$ to assess significance. We computed the ANOSIM analysis using the "vegan" package in R (Oksanen 2019).

In a secondary analysis, we explored differences in street-tree diversity, which we expressed as species richness and the Shannon diversity, density, and basal area across the socioeconomic gradient. As our walking routes within survey locations were all slightly different distances, we standardized our tree species richness data to one km of walking route, which was similar to our adjustments of tree density and basal area. We used either a one-way analysis of variance (ANOVA) or a Kruskal-Wallis test, depending on whether assumptions for parametric linear models were satisfied, with the socioeconomic group as the fixed, categorical factor. When ANOVA or Kruskal-Wallis tests were significant, we computed a multiple comparisons routine using either a parametric Tukey's HSD test or a nonparametric procedure, based on relative contrast effects (nparcomp package in R; Konietschke 2011). We evaluated pairwise comparisons among groups using a Bonferroni adjusted alpha value ($0.05/3 = 0.017$).

To quantify differences in feeding bird composition and foraging observations across the socioeconomic gradient, we again computed an ANOSIM analysis, and an ANOVA test, following a similar approach to the street-tree analysis. To compute our bird-foraging response variable, we determined an $n = 1$ as a unique feeding attempt of a bird on a tree substrate. If we detected a single bird feeding on multiple trees, we used only the foraging behavior and substrate of that bird on the first tree on which we observed it. For year-round birds, some species aggregated into large flocks while moving and feeding (e.g., Bushtits and House Finches). If we detected a large flock feeding on a similar tree species, we recorded each flock as one observation to avoid over-inflating the ecological importance of a given tree on the movement and feeding patterns of a group of birds. If we detected a mixed-species flock feeding, we recorded an $n = 1$ for each year-round bird species represented within the flock. To determine whether we were underestimating effect sizes by our treatment of flock size, we calculated a Spearman's rho (ρ) correlation between our reduced measure of flocks with tallies of all individuals within flocks. We found both metrics to be highly correlated (Spearman's $\rho = 0.81$, $P < 0.01$). This analysis suggests our approach yielded data and results comparable to full flock tallies (Appendix S1). To quantify the number of feeding birds at each survey location, we summed the feeding observations for either the migratory or year-round birds at each survey location across the four visits. Similar to our street-tree richness, density, and size variables, we standardized our bird observation feeding data to one km of a walking route. We thus refer to our feeding observations as "feeding-bird density" measures.

To address our second objective of quantifying relationships between street-tree diversity, density, and size with feeding-bird density, we fit a series of nine single-variable generalized linear models (Table 2). We fit three model sets, in which each set consisted of one of three

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dependent variables, eight independent variables, and the intercept-only model. The dependent variables were (1) the number of observations of feeding migratory birds, standardized per 1 km of a walking route (migratory bird density); (2) the number of observations of feeding year-round birds, standardized per 1 km of a walking route (year-round bird density); and (3) the total number of observed feeding birds, standardized per one km of a walking route (total bird density). In general, we did not notice substantial differences in bird observations between years (Appendix S1: Tables S1, S2). Therefore, we combined avian observation data across the two winter seasons to understand relationships between feeding-bird density and street-tree attributes based on the four visits to each survey location.

We selected eight independent variables that captured both street-tree diversity (species richness and Shannon diversity), as well as the structural attributes of street-tree density and size that may influence bird behavior (DeGraaf and Wentworth 1986). Further, in addition to analyzing the density and size of all street trees, we grouped street trees, whether they were native or nonnative, to understand whether the geographic origin of a tree species influenced feeding-bird density (Appendix S1: Table S3). We considered trees native if they naturally occur in the LA basin, adjacent valleys, and surrounding foothills and nonnative if they naturally occur elsewhere, whether in California outside of the south coast portion of the state, in the United States outside California, or in a different country (Appendix S1: Tables S3). To determine the distribution of trees, we used range maps from the CalFlora database (CalFlora 2019). To assess the strength and directionality of the relationship of each independent variable with a dependent variable, we also fitted the intercept-only model to compare with the dependent variable mean of a model set.

Because our dependent data were density estimates derived from discrete observation variables, we approached our model fitting using Poisson generalized linear models (Zuur et al. 2011). When viewing initial scatterplots, we noticed the variance did not appear to equal the mean, an assumption of Poisson generalized linear models (Zuur et al. 2011). Instead, the variance typically appeared to broaden, depending on the level of the fitted relationship. Thus, to ensure an accurate characterization of the variance of the fitted relationship, we considered either a Poisson distribution or a negative-binomial distribution (both fit using a log-link function; Zuur et al. 2011). To determine whether to use a Poisson or a negative-binomial distribution for each model, we first fitted a Poisson generalized linear model for each relationship. We then assessed the fit of each model by calculating the Pearson v^2 statistic and evaluated the level of overdispersion by calculating the ratio of the residual deviance to the residual degrees of freedom (Zuur et al. 2011). In all cases, fitting a model using the Poisson generalized linear modeling approach yielded a substantial lack of fit, with clear evidence for overdispersion. Thus, we proceeded to fit models using a negative binomial distribution to account for the overdispersion evident in our data (Zuur et al. 2011). After fitting a negative binomial model, we again calculated the Pearson v^2 statistic and checked for overdispersion (Zuur et al. 2011). In all cases, negative binomial models were an adequate fit to the data, and thus, we used this distribution for all fitted models. We computed all generalized linear models using the MASS package in R (Venables and Ripley 2002).

Many relationships displayed hump shapes. In these cases, we fitted the generalized linear models with a quadratic term to account for the hump-shaped relationship. There were no further intricate shapes (e.g., third- or fourth-order polynomial) apparent between variables. To evaluate the fit of the models within each set relative to one another, we used Akaike's Information Criterion (AIC) and a model-selection framework.

To address our third objective of evaluating whether there were patterns in foraging preferences of birds among both native and nonnative street trees, we completed two analyses.

First, to determine whether birds fed on street trees species in differing proportions than they were available throughout the cityscape, we computed a v^2 goodness-of-fit test. To calculate the analysis, we compared observed feeding vs. expected feeding frequencies for migratory, year-round, and total-feeding observations for seven of the 10 study bird species for which we had sufficient observations ($n \geq 30$ feeding observations). We used 21 street-tree species, all of which had an importance value percentage >1.5% as we assumed birds rarely used uncommon street-tree species.

Second, to estimate the selectivity of migratory birds for street-tree species, we calculated preference and aversion values (Holmes and Robinson 1981, Wood et al. 2012). Preference and aversion values are the difference between relative importance values of each street-tree species with that of observed feeding proportions of birds (Gabbe et al. 2002, Wood et al. 2012). Preference and aversion values do not determine resource selection, which requires equal abundance of available resources, but they may represent a bird's preference (positive values) and aversion (negative values) of foraging substrates. We calculated preference and aversion values for the same bird groups and species as the v^2 goodness-of-fit analysis. We used the R statistical software for all analyses and graph creation (R Core Team 2017).

Results

Throughout the two winter field seasons, we surveyed approximately 90 km of street on four occasions, over which we identified, measured, and recorded the position of 7,637 street trees of 85 species (Appendix S1: Table S3). Five tree species were native, and the remaining 80 were nonnative, accounting for 5.46% and 80.51%

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of the total street-tree importance, respectively. Further, in addition to the 85 tree species, we encountered 23 tree families, which were composed of challenging to identify street trees belonging to the same family (e.g., *Fraxinus* spp., Appendix S1: Table S3). These families were most likely comprised of nonnative trees and accounted for 11.50% of the total street-tree importance. Last, we encountered 257 individual nonnative trees that we were unable to identify to species or family. The unknown nonnative group made up the remaining 2.53% of street-tree importance (Appendix S1: Table S3).

Of the native tree species, the coast live oak (*Quercus agrifolia*) and the California sycamore (*Platanus racemosa*) were the only commonly encountered tree species throughout LA (Appendix S1: Table S3). We measured 236 coast live oaks and 79 California sycamore trees, and the average DBH of each species was 76.01 cm and 94.85 cm, respectively (Appendix S1: Table S3). The most commonly encountered street trees of our study were nonnative, with the southern magnolia (*Magnolia grandiflora*), common crape myrtle (*Lagerstroemia indica*), American sweetgum, camphor tree (*Cinnamomum camphora*), and Chinese elm (*Ulmus parvifolia*) being the most abundant (n = 700, 592, 546, 530, and 499 individuals, respectively, Appendix S1: Table S3). The street-tree species covering the greatest area were the camphor tree (n = 404.18 m^2 basal area/km), Italian stone pine (n = 384.74 m^2/km), and Chinese elm (n = 330.67 m^2/km, Appendix S1: Table S3).

We recorded 938 observations of feeding birds, totaling over 10 h of observation time. We documented 587 observations of migratory birds and 351 of year-round birds (Appendix S1: Tables S1 and S2). The most commonly encountered migratory bird was the Yellow-rumped Warbler (n = 348 feeding observations), followed by the Ruby-crowned Kinglet (n = 136 observations), the Townsend's Warbler (n = 69 observations), the Orange-crowned Warbler (n = 23 observations) and the Black-throated Gray Warbler (n = 10 observations, Appendix S1: Table S1). The most commonly encountered year-round bird was the Bushtit (n = 141), followed by the House Finch (n = 96), the Lesser Goldfinch (n = 61), the Anna's Hummingbird (n = 30), and the Allen's Hummingbird (n = 23, Appendix S1: Table S2). Overall, there was little variability between field seasons in observations of migratory and year-round birds (Appendix S1: Tables S1, S2). The only notable differences were for Yellow-rumped Warblers (n = 203, 145), Townsend's Warblers (n = 23, 46), Allen's Hummingbirds (n = 15, 8), and House Finches (n = 64, 32) (Appendix S1: Tables S1, S2).

Objective #1:street-tree and bird composition, diversity, and density

Street-tree and feeding bird composition were significantly dissimilar among low-, medium-, and high-income areas (street-tree ANOSIM $R = 0.13$, $P < 0.01$; feeding bird ANOSIM $R = 0.28$, $P < 0.01$). For both street trees and birds, low- and high-income areas were most dissimilar (street-tree ANOSIM $R = 0.20$, $P < 0.01$; feeding bird ANOSIM $R = 0.55$, $P < 0.01$), followed by medium- and high-income areas (street-tree ANOSIM $R = 0.14$, $P = 0.02$; feeding bird ANOSIM $R = 0.24$, $P < 0.01$), and low- and medium-income areas, which were not significantly dissimilar (street-tree ANOSIM $R = 0.02$, $P = 0.32$; feeding bird ANOSIM $R = 0.01$, $P = 0.33$).

Migratory and year-round birds were five and two times denser, respectively, in high- compared with low-income survey areas, and approximately two times as dense in high- compared with medium-income survey areas, and medium- compared with low-income areas ($F_{2,33}$ = 15.63 and 5.18, $P \leq 0.01$, Table 1, Fig. 3). Tree species richness was similar across the socioeconomic gradient ($F_{2,33} = 0.75$, $P = 0.48$, Table 1). However, lower-income communities had a higher Shannon diversity than medium and high-income regions of the city ($F_{2,33} = 3.20$, $P = 0.05$, Table 1). Street trees were twice as dense and nearly five times greater in size in high-income areas compared with low-income areas (Kruskal-Wallis v^2 = 7.31 and 13.54, $P < 0.03$, Table 1, Fig. 3). High-income areas were also significantly different in tree density and size compared with medium-income areas, while medium- and low-income areas were similar (Table 1). Nonnative trees followed a similar pattern (Kruskal-Wallis v^2 = 13.21 & 11.99, $P < 0.01$, Table 1). Due to low sample sizes, we did not detect significant differences in native tree density and size across the socioeconomic gradient (Table 1). However, native trees in high-income areas were 14 times as dense and covered nearly ten times the area compared with low-income residential areas.

Objective #2: relationships between street trees and feeding bird density

The top-fitting independent variable describing migratory bird density was total street-tree density, which had a ΔAIC value of 2.66 less than the second-best model. The ΔAIC value for the intercept-only model was 27.79, suggesting strong support that total street-tree density best explained migratory bird-feeding density throughout our LA study area (Table 2, Fig. 4). The overall relationship was quadratic, where, in low-income areas, there was a positive relationship between street-tree density and feeding migratory birds (Table 2, Fig. 4). However, as street-tree density increased, the relationship changed to a negative slope (Fig. 4).

The top-fitting model describing year-round feeding bird density was the total-tree basal area (Table 2, Fig. 4). This model was competitive with the nonnative tree basal area (ΔAIC = 1.82, Table 2), but was superior to the intercept-only model (ΔAIC = 7.79, Table 2). Similar to the relationship with street-tree density, the relationship was quadratic (Fig. 4). In low-income areas,

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Table 1. Summaries of feeding bird density, street-tree diversity, and street-tree density and size variables, standardized per 1 km of survey route, across a socioeconomic gradient of low- (<US$53,219, median household income), medium- (US$53,220–US $70,719), and high-income residential communities (>US$70,720) throughout the Los Angeles (California, USA) metropolitan area.

Parameter	Low	Medium	High
Feeding bird density			
Migratory birds	$2.29^A \pm 0.22$	$5.31^A \pm 0.62$	$10.66^B \pm 0.83$
Year-round birds	$2.37^A \pm 0.19$	$3.53^A \pm 0.53$	$5.17^B \pm 0.30$
All feeding birds	$4.66^A \pm 0.31$	$8.83^A \pm 1.06$	$15.83^B \pm 0.97$
Street-tree diversity			
Street-tree species richness	9.06 ± 0.52	9.08 ± 0.65	7.68 ± 0.50
Street-tree Shannon diversity†	$2.46^A \pm 0.09$	$2.25^A \pm 0.09$	$1.87^B \pm 0.11$
Street-tree density and size			
Total street-tree n	$54.10^A \pm 5.25$	$80.47^A \pm 5.49$	$112.84^B \pm 4.12$
Native street-tree n	0.54 ± 0.13	1.07 ± 0.30	7.85 ± 1.67
Nonnative street-tree n	$53.56^A \pm 4.05$	$79.40^{AB} \pm 5.19$	$104.98^B \pm 5.28$
Total street-tree basal area (m^2)	$16.79^A \pm 2.15$	$29.16^A \pm 3.23$	$79.67^B \pm 10.80$
Native street-tree basal area (m^2)	0.70 ± 0.30	0.35 ± 0.11	6.42 ± 1.92
Nonnative street-tree basal area (m^2)	$16.09^A \pm 2.68$	$28.81^A \pm 4.80$	$73.25^B \pm 10.47$

Notes: Variables with the same superscript letter do not differ significantly among socioeconomic groups based on a one-way ANOVA with Tukey HSD test or Kruskal-Wallis test with nonparametric multiple comparisons procedure, with Bonferroni adjusted P value: $0.05/3 = 0.02$. Values are mean ± SE.
†Not standardized to 1 km of walking route.

there was a positive relationship between the street-tree basal area and year-round feeding birds. Conversely, in affluent communities, the relationship shifted to negative as street trees covered more area (Fig. 4).

When relating all feeding birds (i.e., migratory and year-round species combined) to street-tree attributes, street-tree density was again the top predictor variable (Table 2, Fig. 4). The change in the AIC value from the best-fitting model to the second-best model was 2.68, and the ΔAIC to the intercept-only model was 19.81 (Table 2, Fig. 4). Further, the relationship was quadratic and nearly identical to the relationship between migratory birds and street-tree density (Fig. 4). We did not find support that native street-tree density or size were related to feeding-bird density at the extent of our walking routes within LA neighborhoods (Table 2).

Objective #3: foraging preferences of birds among both native and nonnative street trees

Both migratory and year-round birds foraged on particular street trees in unequal proportions than they were available throughout the cityscape ($v^2 = 34.44$, $P = 0.05$ and $v^2 = 46.59$, $P = 0.01$, respectively). The most selective foraging migratory bird species were the Townsend's Warbler ($v^2 = 67.23$, $P < 0.01$) and the Ruby-crowned Kinglet ($v^2 = 61.06$, $P < 0.01$), whereas the most selective foraging year-round bird species were the Lesser Goldfinch ($v^2 = 94.58$, $P < 0.01$), the Anna's Hummingbird ($v^2 = 82.64$, $P < 0.01$), the House Finch ($v^2 = 72.59$, $P < 0.01$), and the Bushtit ($v^2 = 70.04$, $P < 0.01$). Of the seven species in which we had enough data for analysis, only the Yellow-rumped Warbler foraged on street-tree species in similar proportions to their availability, suggesting this species displays a wide breadth of foraging plasticity throughout the LA urban ecosystem during the winter months ($v^2 = 25.79$, $P = 0.21$).

In general, we observed differences in foraging preference and aversion when comparing feeding patterns by birds on native and nonnative street trees (Table 3, Fig. 5a). Migratory and year-round birds preferred foraging on native trees (preference index [PI] = 11.60 and 8.51, respectively) while avoiding nonnative trees (PI = −11.03 and −8.22, respectively, Table 3, Fig. 5b). The observed patterns of feeding preference equated to migratory and year-round birds using native street trees, represented by the coast live oak and the California sycamore, 312% and 255% more than their availability throughout the cityscape (Table 3, Fig. 5b). Building on this finding, the coast live oak had one of the highest preference values by migratory and year-round birds (PI = 8.92 and 6.94, respectively), whereas the California sycamore was lower (PI = 2.83 and 1.70, respectively, Table 3). When comparing patterns of use vs. availability of the two native tree species, individually, migratory and year-round birds used both the coast live oak and the California sycamore in higher proportions (>200%) than their availability (Appendix S1: Table S4, Fig. 5). Migratory or year-round birds did not use the three other native street-tree species that we encountered (Appendix S1: Table S4).

In contrast, migratory and year-round birds used the most common 19 nonnative street trees as foraging substrates 12% and 9% less than their availability, respectively (Fig. 5b). Nevertheless, our analysis did indicate a preference of birds to select nonnative street trees (Table 3, Fig. 5, Appendix S1: Table S4). The Chinese

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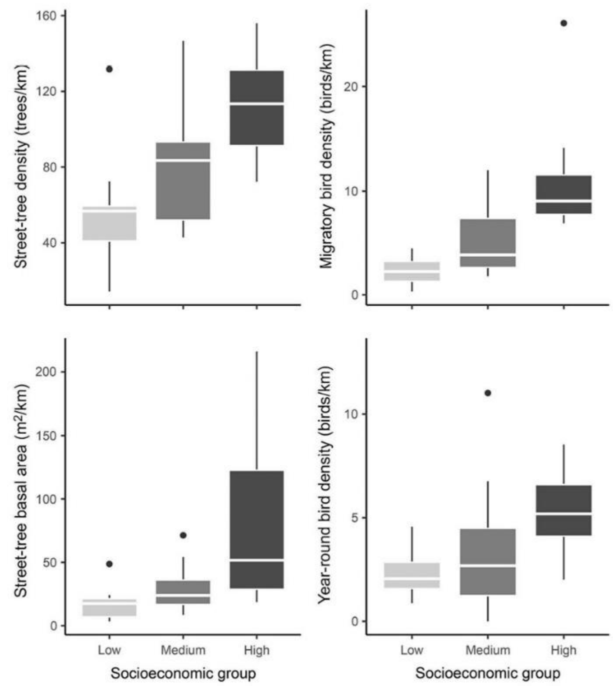

FIG. 3. Box-plot summaries of street-tree density (number of street trees per 1 km of survey route), total street-tree basal area (m^2) per km, and migratory and year-round feeding bird density within 36 residential communities situated across a socioeconomic gradient of low (<US$53,219, median household income), medium (US$53,220-US$70,719), and high-income residential communities (>US$70,720) throughout Greater Los Angeles. In all cases, high-income residential communities harbored significantly greater tree density, tree basal area, and density of migratory and year-round feeding birds than medium and low-income residential communities based on a one-way ANOVA or Kruskal-Wallis analysis followed by a multiple comparisons analysis. The boxplot figures display the median values, the first and third quartile, and the minimum and maximum values, while circles denote outliers.

elm had the highest PI of all street trees by both migratory and year-round birds (PI = 11.52 and 15.09), followed by the carrotwood (*Cupaniopsis anacardioides*, PI = 5.80 and 5.93), southern live oak (*Quercus virginiana*, PI = 3.91 and 0.90), and holly oak (*Quercus ilex*, PI = 1.98 and 0.62, Table 3).

Overall, migratory and year-round birds used seven and six nonnative street-tree species, respectively, in higher proportion than their availability (Appendix S1: Table S4, Fig. 5). All other nonnative street trees, which included approximately 90 species, family groups, or unknown individuals, were generally avoided by feeding birds (Appendix S1: Table S4). The highest proportional use of nonnative street trees by migratory birds was the Chinese elm (255% more than it was available), followed by the carrotwood (254%), southern live oak (227%), and holly oak (202%; Fig. 5, Appendix S1: Table S4). Year-round birds used the Chinese elm and carrotwood in higher proportion than they were available throughout the cityscape (303% and 258%, respectively), followed by American sweetgum (205%), and *Fraxinus* spp. (180%; Fig. 5, Appendix S1: Table S4).

DISCUSSION

Given the pace and dominance of urbanization throughout the globe, understanding how to best manage and conserve biodiversity within city limits is a paramount challenge (Aronson et al. 2017, Lepczyk et al. 2017a). While there are initiatives in metropolises throughout the world to improve environmental quality within cities, understanding the ecology of street trees

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TABLE 2. Model-selection results of three model sets relating migratory, year-round, or total-feeding bird density (dependent variables) to eight street-tree diversity, density, or size attribute variables (independent variables), standardized per 1 km of survey route, within 36 residential communities throughout Los Angeles.

	Migratory			Year-round			Total		
Parameter	ΔAIC	b	b^2	ΔAIC	b	b^2	ΔAIC	b	b^2
Intercept	27.79	6.49		7.79	3.82		19.81	10.31	
Street-tree diversity									
Street-tree species richness	29.03	1.09	1.01	4.80	1.40†	0.98	20.72	1.04	0.99
Street-tree Shannon diversity‡	20.88	3.94†	0.61	9.79	1		18.88	0.72†	
Street-tree density and size									
Total street-tree *n*	0	1.07†	0.99†	4.63	1.03†	0.99	0	1.04†	0.99†
Native street-tree *n*	22.84	1.09†	1	7.18	1.06†	0.99	15.02	1.08	0.99
Nonnative street-tree *n*	2.66	1.08†	1†	5.69	1.03†	1	2.68	1.05†	0.99†
Total street-tree basal area (m^2)	14.12	1.02†	1	0	1.02†	0.99†	5.46	1.02†	0.99
Native street-tree basal area (m^2)	22.14	1.04	0.99	6.91	1.06	0.99	14.74	1.05†	0.99
Nonnative street-tree basal area (m^2)	16.45	1.02†	0.99	1.82	1.02†	0.99†	7.92	1.02†	0.99†

Notes: In addition to modeling all street trees combined within survey locations (total), we grouped tree density and size variables depending on whether street trees were native or nonnative to explore whether tree origin was an important predictor of feeding bird density. We fitted all models using a generalized linear modeling framework with a negative-binomial error distribution, and we ranked models using Akaike's Information Criterion (AIC). A ΔAIC of zero indicated the best-supported model within a set, whereas values >2 suggested less support. We fitted all models, except for the intercept-only model and the Shannon diversity for year-round and total birds, using a quadratic term to account for hump-shaped relationships prevalent in our data. We display the coefficient estimate (b) for both the fitted variable and its quadratic term and indicate the significance of a coefficient estimate with the dagger symbol (†). Further, as the negative-binomial error distribution requires a log-link transformation to estimate parameters, we display the b estimates on the original scale (i.e., exponentiated) for better interpretability. b estimates < 1 indicate negative relationships. The b estimate for the intercept represents the mean of the response variable, whereas the other coefficient estimates can be interpreted as follows; an increase in the independent variable by one unit would result in an increase (or decrease, note the quadratic formula required) of the response variable by a factor of the coefficient value.

‡ Not standardized to 1 km of walking route.

and birds has mostly been overlooked (with exceptions, see Tzilkowski et al. 1986, Young et al. 2007, and Shackleton 2016). Our results provide strong support that street trees have clear and positive value as foraging habitat to birds and thus are a critical resource for promoting urban avifauna. We found that across a socioeconomic gradient throughout LA, feeding bird density was positively associated with increases in density and size of street trees, especially in low- and medium-income communities. Further, our study provided clear evidence for the positive benefit of two commonly planted native street-tree species and a few nonnative tree species as foraging substrates for feeding birds. LA is located within a biodiverse region with avifauna abundant at the edges of the metropolis (Higgins et al. 2019). However, it is likely far more difficult for birds to persist in the most urbanized portions of the city (Blair 1996, McKinney 2006). Our findings indicate that planting and maintaining street trees within the boundaries of the metropolis will likely provide a substantial benefit to feeding birds.

Studies in other areas of the world have also indicated the importance of street trees to avian communities in urban ecosystems (Tzilkowski et al. 1986, Fernandez-Juricic 2009, Shackleton 2016, De Castro Pena et al. 2017). For example, in the cities of Belo Horizonte, Brazil, and Madrid, Spain, bird species diversity was positively related to a diverse and dense street-tree population (Fernandez-Juricic 2009, De Castro Pena et al. 2017). In the towns of Amherst, Massachusetts, and Grahamstown, South Africa, the diversity of bird species occurring on streets increased with both the size (DeGraaf and Wentworth 1986) and the number of street-tree species (Shackleton 2016). In contrast to the studies in Brazil and South Africa, we did not find associations between street-tree richness and diversity and the bird response variables of our study. However, our research uncovered clear relationships with street-tree density and size and feeding-bird density, which supports findings from Spain (Fernandez-Juricic 2009) and New England (DeGraaf and Wentworth 1986). A notable pattern of our results was the consistent humped-shaped relationship between feeding-bird density and street-tree density and size. We found support that increases in street-tree density and size in low-income communities positively benefits feeding birds. However, the relationship shifted to negative in affluent areas. Affluent zones of our study system had far more vegetation in private yards than low-income areas, which is a similar pattern to other studies in LA (Clarke et al.

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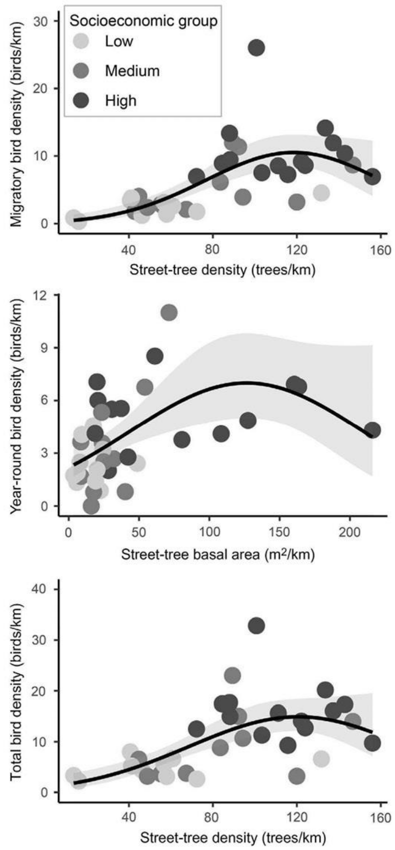

FIG. 4. Scatterplots depicting the relationships between density of feeding migratory, year-round, and total birds (migratory and year-round feeding birds combined) with street-tree density and street-tree size. We derived the fitted smoothed line and estimated prediction intervals from a generalized linear model analysis using a negative binomial error distribution. The color scheme represents survey areas located in 36 residential communities situated across a socioeconomic gradient of low (<US$53,219, median household income), medium (US $53,220–US$70,719), and high-income residential communities (>US$70,720) throughout Greater Los Angeles.

2013). The abundance of vegetation in private yards may have provided additional habitat that attracted feeding birds from street trees (Lerman and Warren 2011, Belaire et al. 2014). Nevertheless, our findings underscore the critical importance to birds of planting and maintaining street trees in sections of the city that are lacking.

Throughout LA, we found that street trees and feeding-bird density were far less in lower-income than affluent communities. Our finding reaffirms support for the luxury-effect hypotheses, which was apparent in our system in low- and medium-income communities (Landry and Chakraborty 2009, Clarke et al. 2013). In LA, Clarke et al. (2013) studied vegetation cover and diversity in a variety of land-use types throughout the residential areas of the city. Their study found that herbaceous and perennial vegetation was positively associated with income. However, they did not find support that tree diversity followed a similar pattern. Instead, the age of building development was the strongest predictor, with older developments having higher tree diversity (Clarke et al. 2013). Similar to Clarke et al. (2013), we did not find differences in the richness of street trees planted in low- and high-income communities. However, our study revealed apparent differences in the density and size of street trees, which is similar to patterns seen in other cities (e.g., Tampa Bay [Landry and Chakraborty 2009], the Eastern Cape of South Africa [Kuruneri-Chitepo and Shackleton 2011], and New York City [Schroeter 2017]). Further, we found that the differences in street-tree density and basal area throughout LA also influenced the density of feeding birds. In addition to fewer and smaller street trees, our study indicated that low-income residential communities of LA harbor a depauperate bird community, which is similar to patterns from other large cities (e.g., Phoenix, Arizona; Lerman and Warren 2011).

While our findings point out deficiencies in urban conservation throughout LA, our results also provide clear evidence for potential improvement. In lower-income communities, we found that even small increases in the density and size of street trees is positively associated with a higher density of feeding birds. These results also hold for locations in LA far from protected areas, suggesting that street trees and birds are a viable target for improving conservation within urban ecosystems. Thus, initiatives to continue promoting trees in areas of a city lacking in street-tree cover will likely have the most significant benefit to urban biodiversity conservation. One such effort, the Million Trees Initiative, has worked to plant trees in locations of LA with low tree density (McPherson et al. 2011). While such initiatives are designed to continue planting and maintaining street trees, tracking the success and long-term viability of planted trees remains a challenge (Dudek 2018). Nevertheless, our results add an extension to the importance of supporting work such as the Million Trees Initiative as well as municipal urban forest programs, including up-to-date inventory and detailed information on tree planting needs.

In addition to the importance of street-tree density and size as predictors of feeding bird density, our study

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TABLE 3. Street-tree species preference (positive) and aversion (negative) values for year-round, migratory, total (year-round and migratory combined), and seven bird species throughout the Los Angeles urban forest.

Tree species	Year-round	Migratory	Total	RCKI	TOWA	YRWA	ANHU	BUSH	HOFI	LEGO
Native										
Coast live oak	6.94	8.92	8.18	15.52	9.16	6.67	16.12	15.27	−1.80	−3.88
California sycamore	1.70	2.83	2.40	2.29	5.81	2.67	−1.44	2.82	0.65	3.48
Nonnative										
Southern magnolia	−7.90	-7.39	−7.58	−8.75	−8.75	−6.41	−8.75	−8.75	−5.63	−8.75
Camphor tree	−4.56	−2.92	−3.53	−4.82	−1.30	−2.10	−5.22	−4.29	−5.42	−3.63
Chinese elm	15.09	11.52	12.86	13.47	23.01	6.95	−7.42	12.44	22.79	25.36
American sweetgum	7.75	−4.79	−0.10	−7.35	−7.35	−2.95	−4.02	−5.94	18.69	33.63
Italian stone pine	−4.58	−3.38	−3.83	−1.70	−1.08	−4.26	−2.10	−5.43	−3.35	−5.43
Common crape myrtle	−3.23	−3.69	−3.52	−4.37	−4.37	−3.20	−4.37	−2.24	−4.37	−4.37
Carrotwood	5.93	5.80	5.85	4.45	3.49	6.80	22.91	11.85	−3.76	−3.76
Mexican fan palm	−3.30	1.54	−0.28	−3.58	−3.58	5.21	−3.58	−3.58	−2.54	−3.58
London plane tree	−3.54	−1.32	−2.15	−2.05	−2.09	−0.61	−3.54	−3.54	−3.54	−3.54
Southern live oak	0.90	3.91	2.79	9.60	4.16	1.31	−3.08	4.72	−3.08	0.19
Brisbane box	−2.70	0.03	−1.00	−1.21	−2.70	0.52	−2.70	−2.70	−2.70	−2.70
Deodar cedar	−1.15	0.83	0.09	2.65	7.57	−0.82	−2.58	0.97	−2.58	−2.58
Brachychiton spp.	−1.82	−1.19	−1.43	−1.64	−2.39	−0.63	0.95	−2.39	−1.35	−2.39
Indian laurel fig	−1.62	−1.68	−1.66	−1.45	−2.19	−1.90	−2.19	−1.48	−2.19	−2.19
Carob	−1.83	−1.09	−1.36	−2.11	−2.11	−0.94	−2.11	−2.11	−2.11	−2.11
Holly oak	0.62	1.98	1.48	3.28	2.41	1.29	−1.94	4.44	−1.94	−1.94
Canary Island date palm	−1.87	−1.70	−1.76	−1.87	−1.87	−1.58	−1.87	−1.87	−1.87	−1.87
Fraxinus spp.	1.26	−0.56	0.12	−0.84	1.31	−0.71	−1.59	−1.59	8.83	−1.59
Jacaranda	−0.95	−0.32	−0.55	0.72	−0.07	−0.64	5.15	−1.51	−1.51	−1.51

Note: RCKI, Ruby-crowned Kinglet; TOWA, Townsend's Warbler; YRWA, Yellow-rumped Warbler; ANHU, Anna's Hummingbird; BUSH, Bushtit; HOFI, House Finch; and LEGO, Lesser Goldfinch.

provided an assessment of the value of over 100 street-tree species (or family groups) to feeding birds throughout LA. We infrequently encountered nearly 80% of tree species in surveys (<1.5% IV), and thus, we treat assessments of the value of the uncommon species with caution. Nevertheless, the most important trees for feeding birds in our study system were a mixture of native and nonnative trees. While other studies have documented the importance of native and nonnative vegetation in urban areas to birds (e.g., Shackleton 2016, Narango et al. 2017, 2018), there were a few notable patterns within our system, including the role of trees in the genus *Quercus*. Oak trees of our study, one native and two nonnatives,- were nearly unparalleled in their use by feeding birds. Throughout the world, trees in the genus *Quercus* are valuable in providing numerous resources for wildlife, including as feeding substrate (Graber and Graber 1983, Rodewald and Abrams 2002) and breeding habitat (Parmain and Bouget 2018). Further, in eastern North America, oaks have some of the highest diversity and abundance of insects when compared with other common trees (Tallamy and Shropshire 2009).

Indeed, the importance of insect prey to feeding birds is becoming apparent in urban ecosystems. In the suburbs of Washington, D.C, plants with high insect food abundance positively benefited foraging and nesting success for the Carolina Chickadee (*Poecile carolinensis* Narango et al. 2017, 2018), while in Dunedin, New Zealand, the native Silvereye (*Zosterops lateralis*) foraged on trees with higher arthropod prey availability (Waite et al. 2013). Local (or native) tree species to a region that are planted in a cityscape have been suggested to harbor higher levels of invertebrate prey available to birds than nonindigenous species (Bhullar and Majer 2000). We did not measure food availability of street trees in our system. Further, our foraging behavioral data indicated similar foraging success among tree species (Appendix S1: Table S5). Nevertheless, our findings of the exceptionally high use of oaks by feeding birds may be due to the important role of oaks in urban ecosystems in structuring a diverse food web. Further, our findings suggest potentially an important functional similarity between native and nonnative oaks to feeding birds in urban ecosystems.

Other important tree species of our study for feeding birds included a sycamore (genus: *Platanus*), an elm (genus: *Ulmus*), and ash (genus: *Fraxinus*). Elsewhere in the world, elm and ash trees are valuable resources to feeding migratory birds (Wood et al. 2012), while sycamore trees provide valuable habitat for birds and other animals (Gabbe et al. 2002, Cudworth and Koprowski 2011). Our initial predictions were that native trees would be superior to nonnatives, and we did find strong support for this for the two most common native tree species of our study. However, we were surprised to find birds preferred a handful of nonnative species, even

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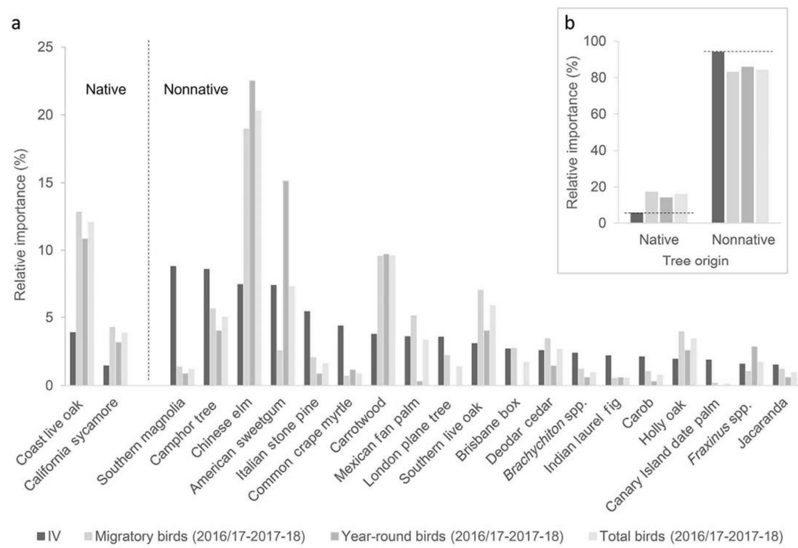

FIG. 5. (a) Relative importance values of common street-tree species (IV), grouped by whether they were native or nonnative in geographic origin, and the proportional use of native and nonnative trees by migratory, year-round, and total birds (five migratory and five year-round species combined) during the 2016–2017 and 2017–2018 winter field seasons throughout Los Angeles. (b) Inset figure depicts the relative importance values of grouped native and nonnative street-tree species, and the proportional use of native and nonnative trees species by migratory, year-round, and total birds. The street-tree importance values represent a tree species' or tree group's availability as a foraging substrate to birds. Bars depicting bird-foraging proportion that are greater than street-tree importance values (horizontal dashed lines provided for reference in inset) suggest bird-feeding preference, whereas bars below street-tree importance values suggest bird-feeding avoidance.

though studies in other urban areas have documented similar patterns (Gray and van Heezik 2016, Shackleton 2016).

Throughout the world, there has been considerable interest and debate about whether to promote native or nonnative trees in urban forests (Kendle and Rose 2000). Some studies illustrate the clear positive benefit of native plants to wildlife (e.g., Ikin et al. 2013, Narango et al. 2017, 2018), while others highlight the value of nonnative vegetation to urban biodiversity (e.g., DeGraaf 2002, Gray and van Heezik 2016, Shackleton 2016). For example, in South Africa, Shackleton (2016) found that nesting birds were more common in native than nonnative street trees. However, the study also noted the importance of nonnative street trees to native mistletoe (Shackleton 2016). In Dunedin, New Zealand, native and exotic birds fed on both native and nonnative trees (Gray and van Heezik 2016). Further, Gray and van Heezik (2016) found that nonnative trees provide food resources outside of the typical timing of native tree phenological events (e.g., berry and seed production). This finding suggests urban areas with nonnative vegetation may provide food resources outside of the typical seasonal pattern of adjacent natural areas. We also found that birds fed on a variety of native and nonnative tree substrates, including leaf surfaces, flowers, and fruits (Appendix S1). Having a variety of food resources available to birds in urban ecosystems throughout the annual cycle may be necessary when considering the effects of climate change on plant and food resource phenology, which in turn may influence bird utilization of a habitat (Wood and Pidgeon 2015).

Our results suggest that if promoting street trees to attract birds is a goal, there are likely numerous factors, in addition to geographical origin, to consider when making decisions about which trees to plant and promote (Kendle and Rose 2000, Sjo€man et al. 2016). For example, LA is situated in an arid biome, and few native trees naturally occur in the region that would be suitable for planting along a street. LA has two of the most common native species of our study, the coast live oak and the California sycamore, planted throughout a handful of sections of the metropolis. However, over-planting each tree could lead to problems. For example, the

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fungal pathogen Dutch elm disease decimated mature elm trees in many cities throughout the United States (Schlarbaum et al. 1997). Currently, the emerald ash borer beetle (*Agrilus planipennis*) is devastating ash trees throughout the midwestern and eastern United States (Poland and McCullough 2006), and in southern California, the South American palm weevil (*Rhynchophorus palmarum*) is currently infesting palm trees (Arecaceae) throughout the region (Hoddle 2019). There are current and potential threats already in the LA area, such as the invasive polyphagous shot-hole borer beetle (*Euwallacea* spp.) and the gold-spotted oak borer beetle (*Agrilus auroguttatus*), which can infest and kill coast live oak and California sycamore trees (Coleman et al. 2011, Kallstrand 2016). Such threats are behind the justification for the 10-20-30 rule, which states that urban tree populations should be no more than 10% of a particular species, 20% of a particular genus, or 30% of a particular family (Santamour 1990). While the 10-20-30 rule has been critiqued (Richards 1993, Raupp et al. 2006), having a diverse street-tree canopy has been the target of many urban areas for providing resilience in the face of potential threats (Kendal et al. 2014, McPherson et al. 2016). Thus, lining streets with the two common native species of the LA region in a homogenous fashion likely raises the risk of possible threats. While there were three other native tree species that we encountered in our study, we could not accurately ascertain their value to feeding birds because these trees were so uncommon.

In more mesic portions of the world, where native tree diversity is higher in locations adjacent to cities, relying more on native tree species that are suitable for urban environments (e.g., tolerance to air pollution; Grote et al. 2016) may be an appropriate strategy when considering planting street trees (Jenerette et al. 2016). However, this may not be optimal for a city such as LA, or other cities in arid regions of the world with relatively poor tree diversity in lowland areas outside the city boundaries (Avolio et al. 2019). Thus, for many municipalities, nonnative street-tree species likely need to be considered when thinking about a resilient urban forest canopy, which is a similar conclusion for cities elsewhere in the world (Sjo€man et al. 2016). Extending this, there are numerous obstacles urban planners must contend with when considering the longevity of urban forests (Pretzsch et al. 2017). For example, when focusing on climate change, climate-adapted trees may be a suitable strategy when weighing the needs of urban residents and wildlife (Jenerette et al. 2016, Lanza and Stone 2016). Our findings suggest that while there are indeed select nonnative street-tree species that provide apparent benefits to feeding birds, many appear to be poor habitat. Thus, careful study of the value of a street-tree species to feeding birds, or other wildlife (e.g., Bhullar and Majer 2000), and considering the other benefits a tree species provides to a city, is necessary for choosing optimal species to promote, especially if conservation is a goal.

Considering our research, we offer the following suggestions for managing street trees to benefit urban avifauna:

(1) *Plantings*: cities must identify critical zones that are lacking in street-tree density. While numerous factors may contribute to a lack of street-tree density, our results, and those of others, suggest this will likely occur in lower-income communities (Landry and Chakraborty 2009, Schroeter 2017).
(2) *Incentivize maintenance*: once cities identify zones that are lacking in street-tree density, promoting, planting, and maintaining street trees should be a goal. Many municipalities are already well-aware of #1 and working to address #2 (e.g., Pincetl 2010). However, this is a difficult task since many units in lower-income communities are often not owner-occupied. Thus, there may be less of an incentive to encourage the growth of a street tree in front of the property (Landry and Chakraborty 2009). In these cases, cities should work to incentivize street-tree care to the property owners or renters or provide public resources to promote the longevity of planted street trees.
(3) *Street-tree density targets*: If cities plant and maintain trees, our results suggest a target of approximately 40–120 street trees/1 km of street will likely attract feeding birds. We note that, in our system, there were few residential study areas with <40 trees/1 km. Thus, our confidence in estimates at these ranges is low. The 40-120 numbers refer to trees on both sides of a street and can likely be halved if only considering one side of a street. Some municipalities may have zones where this is not feasible. If so, our study suggests that even modest increases in street-tree density – coupled with careful consideration of tree species - will likely provide valuable habitat to feeding birds.
(4) *Long-term maintenance*: long-term maintenance of street trees and the encouragement of their growth is imperative to maximize the benefit to urban avifauna. Our results suggest that targeting up to approximately 125 m^2 of the area covered by street trees per 1 km will likely attract feeding birds.
(5) *Inventory*: many municipalities have inventories in place detailing information such as the location, size, date planted, health, and species of tree, for all street trees within city boundaries. Having a detailed street-tree inventory is a critical step for municipalities to understand how to manage street trees based on a city's needs, including providing assessments (the current study) and services to aid biodiversity (Dudek 2018). Further, detailed inventories allow for appropriate planning of diversity targets for street trees (Santamour 1990, McPherson et al. 2016).
(6) *Native and nonnative trees*: our study indicates that the common native trees of our region, along with a

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handful of nonnative street trees can be beneficial to feeding birds. We do stress that the vast majority of nonnative trees in LA appear to provide little apparent benefit to the feeding birds of our study. Thus, our work suggests that careful consideration is required to determine the best street trees to plant and maintain if providing habitat for birds is a goal. If possible, municipalities should use available information (e.g., National Audubon Society 2019) coupled with careful study to identify which trees will provide essential services to both humans and birds.

(7) *Value of studying feeding birds*: while there are numerous taxa of wildlife found in cities that likely utilize street trees (e.g., insects, birds, mammals), we suggest focusing attention on feeding birds. Birds are one of the most abundant and diverse wildlife taxa in most cities throughout the world (Lepczyk et al. 2017b). Further, they are relatively easy to study compared with other abundant taxa (e.g., insects; Bhullar and Majer 2000). A bird feeding on a tree substrate is an intricate and detailed ecological process that yields great information about which trees are beneficial to birds, and possibly other wildlife (Holmes and Robinson 1981, Gabbe et al. 2002, Wood et al. 2012). If municipalities already have tree inventories in place (see #5), a study needs to only focus on observing feeding birds on street trees in a given area over a given period, which can then be compared with the detailed street-tree data similarly as this study. A unique component of LA's avifauna are wintering migratory birds. In different urbanized locations of the world, a study such as ours could consider *en-route* migratory birds (e.g., urban stopover locations, Amaya-Espinel and Hostetler 2019) or breeding species (DeGraaf and Wentworth 1986). City personnel, arborists, students, volunteers, or citizen-science initiatives can accomplish a study detailing the behavior of feeding birds on street trees.

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Foreword

Life on Earth has evolved over billions of years under cycles of natural light and darkness that vary diurnally and annually. Artificial light at night (ALAN), and sometimes also at daytime, can cause deviations from these natural patterns of darkness and may thus interfere with natural physiological and ecological rhythms (LONGCORE & RICH 2004, HÖLKER *et al.* 2010a, GASTON *et al.* 2013, 2015). In mammals, physiological features such as sleep, food digestion, immune response and body temperature are tightly adjusted to the diurnal light cycle (ARENDT 1998). ALAN may disrupt these physiological processes and may further interfere with orientation and navigation, with severe consequences for individual behaviour, local animal populations and whole ecosystems (RICH & LONGCORE 2006; GASTON *et al.* 2015).

Among vertebrates, bats are almost exclusively nocturnal and extremely sensitive to ALAN, (HÖLKER *et al.* 2010a, SPEAKMAN 1995, VOIGT & LEWANZIK 2011, BENNIE *et al.* 2014a). The information we have on the impact of ALAN on bats is gradually expanding, and helps us formulate management recommendations to mitigate the impact of old and new lighting schemes. The information currently available is a combination of scientific studies, case-reports, and the extensive experience of bat workers. An integration of this information forms the basis of these EUROBATS guidelines. However, it is important to measure the degree of success of the mitigation strategies described in this document, and determine whether they achieve local and landscape-scale benefits for bats. Further, it is important to investigate how these measures can be improved. In addition, quantitative assessments of the effectiveness of mitigation – vital to refine and improve strategies for the future – can only be achieved if structured data are collated from multiple sites.

In these guidelines, we tried to compile available evidence related to the effect of ALAN on bats, a field of research that is very dynamic. Using the current state of knowledge, solutions are formulated on how to avoid, mitigate or compensate the adverse effects which ALAN has on bats in their network of functional habitats, consisting of roosts (maternity, summer, transient, feeding, mating and/or hibernation), ***commuting routes*** and ***migratory*** corridors, ***foraging areas*** and ***swarming sites*** (hereafter, terms highlighted in bold and italics are included in the Glossary).

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1 Introduction

All European bat species are protected by several international and European binding treaties, (*e.g.* by the ***EU Habitats Directive***). The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an intergovernmental treaty concluded under the aegis of the United Nations Environment Programme (UNEP). Migratory species threatened with extinction are listed in the Appendix I to the Convention whereas migratory species that need or would significantly benefit from international co-operation (including all European bat species) are listed in the Appendix II. The Agreement on the Conservation of Populations of European Bats (EUROBATS) was set up under the Bonn Convention and aims to protect all European bat populations through legislation, education, conservation measures and international co-operation. According to the fundamental obligations, each EUROBATS Party shall identify important roosting sites and ***feeding areas*** for bats and protect such sites and areas from damage or disturbance such as ALAN.

The Habitats Directive requires that Member States do more than simply prevent the further decline of populations of the listed species. For the priority bat species, included in Annex II, they must also undertake positive conservation measures to ensure that populations are maintained and restored to a favourable conservation status throughout their natural range within the EU. Consequently, responsible authorities in all European countries shall ensure that bat populations are protected also from disturbance caused by light pollution.

A nocturnal lifestyle is inherent to all bats. They usually hide in roosts during the daytime, while fly to ***feeding areas*** or drinking sites using ***commuting routes*** during the night. On the annual scale, bats of the temperate zone aggregate in late summer and autumn for ***swarming*** and later spend the winter in hibernacula. Many bat species move between different roosts and habitats, whereas other perform long-distance ***migrations*** between reproduction and hibernation areas in different parts of Europe (HUTTERER *et al.* 2005). In all situations, ALAN may significantly change their natural behaviour (STONE *et al.* 2015a; ROWSE *et al.* 2016). A hypothetical case is presented in Figure 1.1. Overlap of illuminated patches with ***foraging areas*** and ***commuting routes*** results in a potential conflict between ALAN and bat conservation. *Plecotus auritus* would stop to use the lit side of the church for emergence; illuminated patches may disrupt flight paths of the bats and affect their foraging areas: tree lines and shores (*Pipistrellus pipistrellus* and *Plecotus auritus*) and waterbodies (*Myotis daubentonii*).

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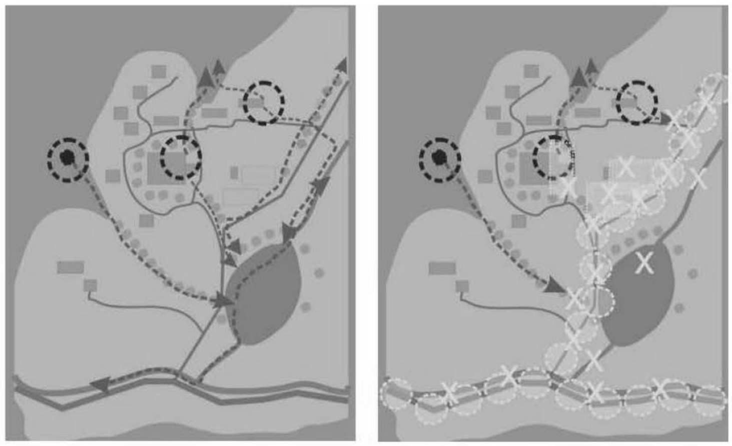

Figure 1.1. Schematic network of roosts, commuting routes and foraging areas of 3 bat species in a situation without ALAN (left picture) and with ALAN (right picture). Red rectangles denote buildings in a village, surrounded by forest (dark green); green circles - individual trees; blue areas - water bodies; grey lines - roads; green rectangles - stadiums. Roosts are encircled by dark blue dashed lines: M. daubentonii *roosting in a tree in the forest, long-eared bats roosting in the church attic (large red rectangle in the village centre) and* P. pipistrellus *roosting in a house. Commuting and foraging areas - red dashed lines with arrows. Illuminated areas are surrounded by yellow dashed lines. Crosses indicate places where the movement through the landscape is blocked by ALAN or the habitat is no longer functional.*

Bats are naturally exposed only to very low lighting levels produced by moonlight, starlight and low intensity twilight (Fig. 1.2). There are rare exceptions of daylight flight activity, such as in *Nyctalus azoreum*, a noctule species from the Azores (SPEAKMAN 1995), and in bats at northern latitudes that forage in daylight when nights are shortest (SPEAKMAN *et al.* 2000). In general, bat eyes are specialised for low light levels (SHEN *et al.* 2010). Light levels as low as typical full moon levels, *i.e.* around 0.1 lx, are known to alter the flight activity of bats. It is important to note that the unit **lux** (symbol lx) is defined according to human spectral sensitivity and determining its relevance for animals with different spectral sensitivities can be problematic. We refer to this unit below, since it may facilitate interdisciplinary communication between biologists, the lighting community and developers.

Any level of artificial light above that of moonlight masks the natural rhythms of lunar sky brightness and, thus, can disrupt patterns of foraging and mating and might, for instance, interfere with entrainment of the circadian system (Fig. 1.3 and 1.4). In

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Figure 1.2. Two Plecotus auritus with rising full moon in the background (© J. Rydell).

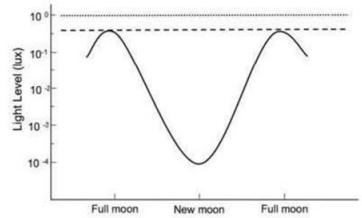

Figure 1.3. Skyglow can mask natural rhythms of lunar sky brightness. The solid line depicts full moon light levels in a temperate habitat without light pollution. The dashed and dotted lines indicate skyglow light levels under clear and cloudy skies respectively, as measured in the centre of Berlin. Figure from Perkin et al. (2011).

Figure 1.4. Skyglow outshining stars and the Milky Way in Cazorla City, Spain (© Jens Rydell).

the lab, even ***illuminance*** as low as 10^{-5} lx was sufficient for the entrainment of circadian rhythm of the Pallas's Mastiff Bat (*Molossus molossus*), the lowest threshold value observed for photic entrainment in vertebrates (Erkert 2004). Consequently, ALAN that may affect bats negatively can be of very low intensity: some bat species are repelled by very low light levels of only 4.5 lx (Lewanzik & Voigt 2016), 3.6 lx (Stone *et al.* 2012), 3.2 lx (Kuijper *et al.* 2008) and 1.9 lx (Lacoeuilhe *et al.* 2014). In comparison, those levels are all lower than the ***illuminance*** level of residential side streets, which is on average about 5 lx at street level, but which often is higher than this (Gaston *et al.* 2012, Azam *et al.* 2015).

Bats possess colour vision (Müller & Peichl 2005), including the ability to perceive UV (Winter *et al.* 2003, Müller *et al.* 2009, Gorresen *et al.* 2015), though UV sensitivity has been lost in some species, including horseshoe bats (Zhao *et al.* 2009). The general sensitivity of bats to light is obvious. Some species adjust their activity in response to the lunar cycle (*e.g.* lunar phobia), a response that is especially pronounced in species that forage over water and in the forest canopy, and live in tropical areas (Saldaña-Vázquez & Munguía-Rosas 2013; Roeleke *et al.* 2018). Polarised light at sunset seems to be important for orientation, *e.g.* for calibrating the magnetic compass of some bats (Greif *et al.* 2014). However, migratory species may represent an exception (Lindecke *et al.* 2015). Bats may also obtain cues from city lights for homing (Tsoar *et al.* 2011) and possess the visual acuity to use information from stars for navigation (Childs & Buchler 1981, Eklöf *et al.* 2014). Bats may demonstrate reduced homing performance, if deprived of visual cues (Davis & Barbour, 1970). Thus, ALAN has the potential to seriously interfere with the vision and behaviour of bats.

ALAN is produced in a variety of ways, for example by street lights, illuminated buildings, lit advertisements, security and domestic lights, lights on vehicles, gas flares and stadiums (Kyba *et al.* 2015, Schoeman 2015; Fig. 1.5). An in-depth remote sensing study of Berlin showed that almost a third of the emitted light came from streets, with considerable amounts of light also originating from industrial areas (16%), public service areas (10%), block buildings (8%), city centre (6%), airfields (4%) and supply and disposal facilities (4%) (Kuechly *et al.* 2012). Direct lighting

Figure 1.5. Artificial light at night from various sources such as streetlamps, illuminated buildings, lit advertisements, domestic lights, lights from vehicles, resulting in bright skyglow over Israel in the background. The image was captured from the West Bank, which is much darker and with less skyglow (© J. Rydell).

is affected by physical features of the atmosphere and terrain; it can also be scattered by atmospheric molecules or aerosols, especially under cloudy conditions (Aubé 2015, Kyba *et al.* 2015). Although the scattered artificial light (see ***skyglow***) is relatively dim and homogenous compared with point sources such as street lights, it is still bright compared to natural light sources, such as stars, and spreads over vast areas (Kyba & Hölker 2013, Falchi *et al.* 2016).

The spectral content of light can differ depending on the source (Fig. 1.6, Table 1.1), and many animals (including bats and insects) are able to perceive wavelengths beyond the range that humans can. For street lights, high-pressure mercury vapour (HPMV) lamps emit what humans recognize as blue-white light containing considerable amounts of UV. Low-pressure sodium (LPS) lamps emit monochromatic orange light, while high-pressure sodium (HPS) lamps emit a broader spectrum of mainly orange-yellow wavelengths. New technologies include light-emitting diodes (LEDs) and metal halide lamps. LEDs are available in 'warm white' and 'cold white' varieties, and typically do not emit UV. Metal halide lights emit UV, similar to HPMV lamps. Domestic lighting traditionally included many tungsten filament lamps that heat up to produce visible light (by incandescence). These lamps are being replaced by compact florescent lamps (that emit some UV), and especially by LEDs. The UV component of lamps seems to be especially important in determining how attractive lamps are to insects: lamps that emit UV attract more

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insects (EISENBEIS & EICK 2011; WAKEFIELD *et al.* 2016; 2018), and it has been shown that blue wavelengths attracted considerable more moths than lights of longer wavelengths (VEROVNIK *et al.* 2015). The dense concentrations of insects around these light sources may attract hunting bats of some species (*e.g.* RYDELL 1991).

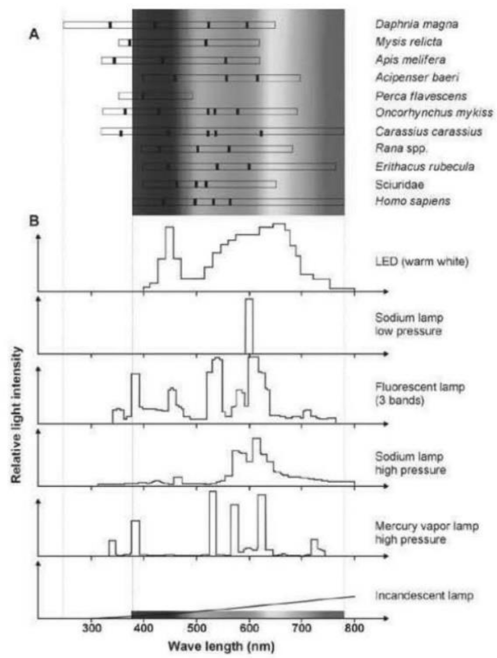

Figure 1.6. (A) The light sensitivities various animals displayed against a background of wavelengths that humans perceive as visible light. The dashed vertical lines cover the range of wavelengths, which the listed animals can perceive. Black marks in bars represent peak sensitivities of visual pigments for small crustaceans: Daphnia magna *and* Mysis relicta; *insect* Apis mellifera *(honeybee); fish* Acipenser baeri *(sturgeon),* Perca flavescens *(perch),* Onchorhychus mykiss *(trout) and* Carassius carassius *(carp); amphibians* Rana spp. *(frogs); bird* Erithacus rubecula *(robin) and mammals* Sciuridae *(squirrels) and* Homo sapience *(human). Figure (B) shows the wavelengths of light emitted from a range of artificial light sources. Some lamps emit light in the UV, and the spectral width varies among lamp types considerably. © PERKIN et al. (2011).*

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Spectrum	Types of lamps	% sales	Colour	UV	CCT	LE	CRI
Narrow	Low Pressure Sodium	37	Orange	0	1807	80-150	NA
Broad	High Pressure Sodium		Orange-yellow	+	2005-2108	45-110	22-80
Broad	High/low Pressure Mercury	27	White	++	2766-5193	25-52	22-43
Broad	Metal Halide	36	White	++	2874-4160	45-150	65-95
Broad	Light Emitting Diode	NA	White	0	1739-8357	160	>90

Table 1.1. Percentage of most common lamps sold in the EU from 2004 to 2007 (EUROPEAN COMMISSION 2011) as well as their physical characteristics extracted from GASTON al. (2012) and from personal data of Georges Zissis. CCT refers to Correlated Colour Temperature (Kelvin); LE refers to Luminous Efficacy (lumens/W); CRI refers to Colour Rendering Index; NA - data are not available.

The growth of the human population and associated processes of urbanisation have resulted in further increases of ALAN at a rate of about 2–6% per year, resulting in ALAN being identified as an important threat to biodiversity (HÖLKER *et al.* 2010a; KYBA *et al.* 2017). Further, the switch to cost-effectiveness of LEDs has led to a so-called rebound effect, which describes the phenomenon that the increasing use of inexpensive LED outdoor lighting has further accelerated the spread of ALAN worldwide (KYBA *et al.* 2017).

Eighty percent of the world's population now lives under light polluted skies, and the Milky Way is no longer visible to more than a third of humanity (FALCHI *et al.* 2016). The rate by which ALAN increases is faster than the rise in human population and economic growth (HÖLKER *et al.* 2010b). Although European directives have resulted in HPMV lamps being phased out, changes in and implementation of ALAN is unregulated across much of the EU, either generally, or specifically for bats.

Not only the amount of ALAN is increasing, the spectral content of light is changing too. In 2015, HPMV lamps were banned from new lighting installations in the EU in order to reduce costs and CO_2 emissions. In addition, street lighting is rapidly becoming whiter with many sodium lamps being replaced by LEDs, and to some extent by metal halide lamps both of which provide better colour rendition for humans. But, they still include light spectra (UV, blue light) with negative impacts on insects, bats main prey. There are potential benefits to these changes: new technology street lights are programmable from a central control centre, so their light intensity and timing of operation can be modified quickly and over large spatial scales.

In summary, the nightscape is changing as ALAN becomes more prevalent, and it also changes with technological advances that change lighting spectra. The effects of ALAN in general and of specific lighting schemes in particular on biodiversity, including bats, are currently poorly understood. Yet, it is agreed on by all specialists that bats, being nocturnal, are especially affected by ALAN. In the following chapter, we will summarize the state of knowledge with respect to how bats respond to ALAN.

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2 Response of bats to artificial light at night

Early observations by *e.g.* GRIFFIN (1958) and ROEDER (1967) of bats chasing moths at street lights, which at that time usually were of the light-bulb type, suggests that bats coming near artificial lights to feed is as old as the use of such lights, *i.e.* approximately since the 1920´s. A first quantitative study on the impact of increased levels of natural light on bats was made by NYHOLM (1965). He recorded that *Myotis daubentonii* and *M. mystacinus/M. brandtii* consistently avoided their preferred habitats, *i.e.* lakes and forest gaps, in response to the brightness of the Nordic midsummer nights. However, his observations did not include areas illuminated by artificial light, which were still few at that time, but highlighted the relevance of light for the overall activity and habitat use of bats. Soon naturalists and bat biologists observed differences in the way bat species responded to ALAN, and these behavioural differences were most often related to specific flight styles, *i.e.* fast-flying species were found to be more opportunistic to ALAN than slow-flying and hovering species. These differences were explained by the specific capability of species to avoid visually-oriented predators such as birds of prey (RYDELL *et al.* 1996). Some bat species were also observed being attracted to ALAN because they feed on insects lured by the artificial light source (RYDELL 1991). Following this attraction and avoidance scheme, bat species have been grouped into classes of species which are "sensitive to light" and those which are "tolerant to light" or even "attracted to light". However, ROWSE *et al.* (2016a) recently suggested a reconsideration of this simplistic categorization. For a proper assessment of the impact of ALAN on bats in specific situations, several other factors must be considered.

Bats have evolved in darkness or dim light throughout their history and have become adapted to a nocturnal life over millions of years (RYDELL & SPEAKMAN 1995; VOIGT & LEWANZIK 2011). Darkness is the principal protection against predation for bats in most situations. A comprehensive review of predation on bats at roosts and elsewhere was recently provided by MIKULA *et al.* (2016). Bats are preyed on by various predators under many different conditions, both inside roosts and in flight. The activity patterns of bats and eventually their survival and reproduction rates are often constrained by predation (SPEAKMAN 1991). Emergence and foraging behaviour of individual bats are most likely governed by simple rules of optimality, such as the trade-off between the expected costs, including energetic costs of locomotion and predation risk, and the likely benefits of foraging such as energy intake. Yet, this relationship is far more complex, since it depends on various circumstances. First, the response of a bat

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to ALAN depends on its nutritional status, which in turn is influenced by *e.g.* reproductive state, sex and age. According to a study on emergence time in three European species, bats emerge relatively early, and hence take higher risks, when being under nutritional stress due to persistent low ambient temperatures, during pregnancy, or when body reserves were low (Duvergé *et al.* 2000). Second, the responses to ALAN also depend on the specific location of bats and the specific motivation of bats for their presence in a habitat, *i.e.* the quality and functional relevance of a habitat. Third, natural or artificial light at any particular location may affect insect availability, as well as the presence of competitors and predators, and these factors influence the presence of bats (Rydell *et al.* 1996). Finally, wavelength, intensity and directionality of the light may be important as well (Mathews *et al.* 2015). In summary, the effect of ALAN on bats depends both on species and context (Fig. 2.1).

ALAN may make a location less attractive for one species, but more attractive for another, supposedly even resulting in competitive exclusion of some light-averse species (Arlettaz *et al.* 2000). On a larger scale, extensive use of ALAN along

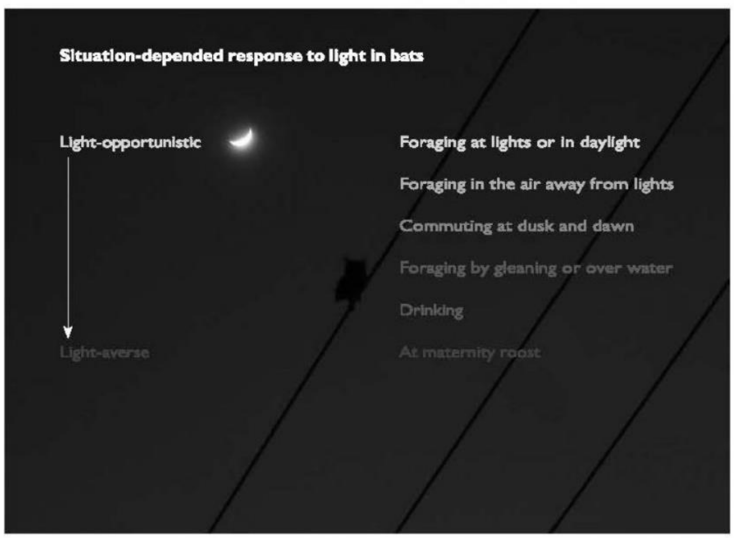

Figure 2.1. A hypothetical example illustrates the context-dependent response of opportunistic and light-averse bats. Note that a single species may display all responses and that these responses may vary seasonally because of factors such as reproduction, migration and hibernation (© J. Rydell).

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with urbanisation in general may change bat species composition dramatically over large areas. Consequently, the relatively species-rich communities in unlit areas may be replaced by species-poor communities of opportunistic species that increase in abundance in relation to the intensity of ALAN, resulting in a simplification of the local bat fauna (*e.g.* GAISLER *et al.* 1998; SCHOEMAN 2015; RUSSO & ANCILOTTO 2015; LEWANZIK & VOIGT 2016).

2.1 Impacts of ALAN on insects

European bats in general depend on insects for food and in order to understand the response of bats to ALAN, it is important to know how nocturnal insects respond to ALAN. Most nocturnal insects show phototaxis, that often involves considerable attraction towards and trapping of individuals at artificial light sources (ALTERMATT *et al.* 2009; PERKIN *et al.* 2014; VAN GRUNSVEN *et al.* 2014; VEROVNIK *et al.* 2015). Short wavelength emissions in the blue (< 490nm) and UV ranges (< 380nm) are responsible for this "flight-to-light" behaviour because most nocturnal insects have a peak of visual sensitivity in the UV, green and blue portion of the wavelengths spectrum (VAN LANGEVELDE *et al.* 2011; SOMERS-YEATES *et al.* 2013; PAWSON & BADER 2014). Hence, UV-emitting lamps such as HPMV, metal-halides and compact fluorescent lamps, attract significantly more insects than LED and HPS lamps, which emit less UV (SOMERS-YEATES *et al.* 2013; VAN GRUNSVEN *et al.* 2014; WAKEFIELD *et al.* 2016; 2018). Nevertheless, LED and HPS lamps have broad spectrum emissions including wavelengths in the blue range. Blue range has been shown to attract significantly more insects than yellow range light (VEROVNIK *et al.* 2015). In one study, both "cold" and "warm-white" LEDs attracted significantly more insects than HPS lamps (PAWSON & BADER 2014). But, EISENBEIS (2013) found that LEDs attracted fewer insects than HPS and another study (WAKEFIELD *et al.* 2018) reported no difference in the attraction of flying insects to LED and HPS lamps (though LEDs attracted more insect families).

The attraction effect of HPS lamps has been reported to work up to 23m from street lights for moths and 40m for aquatic insects (PERKIN *et al.* 2014; DEGEN *et al.* 2016). Because the typical distance of municipal street lights for roads in the EU ranges between 20 and 45m, it is likely that moths crossing an urban road will be trapped in the zone of street light interference, which causes a further fragmentation of the night habitat, and may reduce landscape connectivity (DEGEN *et al.* 2016). Overall, ALAN appears to generate an accumulation of insect biomass in illuminated patches and may induce a depletion of insects in dark areas near street lights or other outdoor luminaries, a so called "vacuum cleaner effect of illumination" (EISENBEIS 2006, VEROVNIK *et al.* 2015). This shift in the spatial distribution of insects induced by ALAN likely triggers cascading impacts on their predators including bats, as it generates high quality foraging patches for opportunistic species, while decreasing the size and quality of dark areas for light-sensitive species (*e.g.* MANFRIN *et al.* 2018).

The attraction effect of ALAN to insects likely causes massive mortality as individual insects can be killed directly by the

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heat of lamps, or they may circle the light until exhaustion, or until being caught by predators (Eisenbeis 2006). In particular, natural as well as artificial light inhibits the evasive flight response of tympanate moths to bat echolocation calls, leading to an increase in the predation success of bats at *e.g.* street lights (Svensson & Rydell 1998; Svensson *et al.* 2003; Wakefield *et al.* 2015).

Additionally, ALAN probably reduces the reproduction success of exposed insect populations as it reduces sex pheromone production and inhibits mating in moths (van Geffen *et al.* 2015a, 2015b). These adverse impacts on moth reproduction occurred regardless of the wavelength spectrum of the lamp, suggesting a negative effect of ***illuminance*** on moth populations (van Geffen *et al.* 2015b). Furthermore, exposure of moth caterpillars to green and white lights probably decreases individual fitness by inducing a lower body mass of caterpillars and pupae and an advance in the date of pupation compared to conspecifics from red light and dark conditions (van Geffen *et al.* 2014).

Finally, many arthropods use celestial cues such as the moon, stars or skyline, for orientation (Dacke *et al.* 2013; Schultheiss *et al.* 2016). Hence, ALAN, including ***skyglow*** above cities, may negatively impact the dispersal movements of populations by masking natural lighting signals at night, with important implications for metapopulation dynamics and gene flow (Baguette *et al.* 2013; Kyba & Hölker 2013). Further, ALAN may also impact the fitness, mortality, and reproduction of insects which may ultimately induce long-term population declines in illuminated areas. Common macromoths in the UK have experienced major declines in recent decades (Conrad *et al.* 2006), and it has been hypothesized that urban areas and their associated ***skyglow*** may act as ecological sinks, depleting the surrounding landscapes of moth species (Bates *et al.* 2014). Thus, the widespread use of ALAN may induce a landscape-scale depletion of insect biomass, which in turn may negatively affect bat population trends by decreasing the amount of foraging resources (Azam *et al.* 2016).

Artificial lights may also inhibit the entire flight activity of nocturnal moths and other insects, because the conditions near the light source may simulate daylight or strong moonlight, both of which normally lead to inactivity in nocturnal moths (Williams 1936). If lit conditions persist continuously in an area, nocturnal insect activity may be expected to decline for this reason alone. In addition, bats prey upon such inactive moths sitting directly in the illuminated building walls (Verovnik *et al.* 2015).

The long-term impact of ALAN on insect populations is largely unknown, however, but recent evidence of dramatic declines in moths and other insects in Western Europe are quite alarming and suggest that the effect is already serious (Conrad *et al.* 2006; Hallman *et al.* 2017). Part of the observed decline can be linked to the increasing use of ALAN because larger moths and other phototactic insects are affected more seriously than others (*e.g.* diurnal or non-phototactic) insects (van Langevelde *et al.* 2018). Ecosystem services such as pollination provided by nocturnal insects are

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disrupted seriously in lit areas but not in nearby unlit control areas (MACGREGOR *et al.* 2016) and may even have knock-on consequences for diurnal pollination interactions (KNOP *et al.* 2017). In the long run, general decline in insect populations will obviously have negative effects on bats as well as on many other animals and perhaps on entire ecosystems.

2.2 Light averse and opportunistic bat species

Overall, European bats are all well adapted to nocturnal conditions, including a need for protective cover provided by darkness, and it can be expected that ALAN affects them in most situations (RYDELL & SPEAKMAN 1995).

At the genus level, European bats can roughly be categorized according to the way they respond to ALAN (Table 2.1). This taxonomic simplification seems acceptable, because species of the same genus appear to show a similar response to ALAN, probably owing to similar wing morphology, habitat requirements and life history features. We distinguish between averse, neutral and opportunistic responses. An averse response means that the bat would normally avoid ALAN. A neutral response means that ALAN would not influence the spatial distribution and activity of a bat. An opportunistic response means that the bat turns towards locations with ALAN under certain conditions, for example for feeding, as the expected benefit due to higher insect density near artificial lights may outweigh the potentially increased predation risk. Such species may dominate at illuminated places. We avoid applying the terms "light-tolerant" or "light-exploiting" to bats, because they overlook the fact that the reaction of a species can be different, depending on multiple factors. Even species that readily forage on insect aggregations around street lights might avoid artificial light when commuting (HALE *et al.* 2015) or close to their roost (DOWNS *et al.* 2003).

Bats of some genera (*Nyctalus*, *Vespertilio*, *Miniopterus* and *Tadarida* spp.) typically feed and commute in the open space above vegetation and buildings and may only sometimes fly under or near street lights or floodlights. We have denoted these bats with n.a. (not applicable), although we acknowledge that they may still exploit insects attracted to ALAN by feeding above lit urban areas or illuminated infrastructure elements, *e.g.* at floodlights on airports, train stations and stadiums (*e.g.* KRONWITTER 1988, RYDELL 1992, RUSSO & PAPADOTOU 2014). Hence, they may be considered as "opportunistic", like the pipistrelles and the species of the genus *Eptesicus*, although their behaviour usually is less obvious when observed from the ground. They usually fly at heights above the directly lit zone but within the area influenced by ***skyglow***. Information concerning response to ALAN during long distance ***migrations*** is available only for a few species of the genus *Pipistrellus* (VOIGT *et al.* 2017), therefore we did not include migratory behaviour in Table 2.1. We consider maternity roosts, mating roosts and ***swarming*** sites as "roosts", but temporary night roosts used by single or only a few individuals are excluded, since there are no quantitative studies estimating the effect of ALAN at night roosts.

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Genera	Daytime Roosts	Commuting	Foraging	Drinking	Hibernacula
Rousettus	Averse	Neutral	Neutral	Averse	Averse
Rhinopoma	Averse	DD	DD	Averse	Averse
Rhinolophus	Averse	Averse	Averse	Averse	Averse
Barbastella	Averse	Averse	Averse	Averse	Averse
Eptesicus	Averse	Averse	Opportunistic	Averse	Averse
Pipistrellus and *Hypsugo*	Averse	Neutral/ opportunistic	Opportunistic	Averse	Averse
Myotis	Averse	Averse	Averse	Averse	Averse
Plecotus	Averse	Averse	Averse	Averse	Averse
Vespertilio	Averse	DD	n.a./opportunistic	Averse	Averse
Nyctalus	Averse	DD	n.a./opportunistic	Averse	Averse
Miniopterus	Averse	DD	n.a./opportunistic	Averse	Averse
Tadarida	Averse	DD	n.a./opportunistic	Averse	Averse

Table 2.1. The likely taxon-specific response of bats to ALAN in relation to specific situations. The table is based on available literature and personal observations of the authors. Note that Nyctalus azoreum, *as well as* Eptesicus nilssonii *in the far north, may fly in broad daylight. N.a. = not applicable, DD = data deficient. Averse, neutral and opportunistic are defined in the text.*

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2.3 Two illustrative cases of bat responses to ALAN

The complex response of bats to ALAN may be illustrated by the behaviour of two species that have been studied in detail, the notch-eared bat *Myotis emarginatus* and the northern bat *Eptesicus nilssonii*.

Although *M. emarginatus* belongs to the light-averse group, it occasionally forms maternity colonies in barns and attics that are sometimes brightly illuminated (Fig. 2.2). Nevertheless, when entrances to such maternity roosts are illuminated, notch-eared bats may emerge later than usual (Moermans 2000), which may reduce the total time available for foraging per night. This can lead to a slower growth of the young (Boldogh *et al.* 2007). In the Netherlands, radio-tagged *M. emarginatus* commuted in or above the canopy, thus avoiding lit areas, but can be seen foraging inside both lit and unlit stables (Dekker *et al.* 2013). Presumably, this dualism in response depends on the trade-off between feeding success and either real or perceived predation risk for various habitats. For *M. emarginatus*, the perceived predation risk is probably lower inside than outside stables.

Considered as relatively light-opportunistic, *E. nilssonii* often forages along rows of street lights (patrolling), where individuals sometimes establish and defend feeding territories (Fig. 2.3). However, they only occasionally dive into the light cone in pursuit of an insect. Such dives are short (less than one second) and unpredictable to a

Figure 2.2. Cluster of notch-eared bats Myotis emarginatus *in a maternity roost in the Netherlands, 2016 (© J. Dekker).*

Figure 2.3. The northern bat Eptesicus nilssonii *diving into the light cone of a mercury vapour streetlamp in Sweden (© J. Rydell).*

human observer. While patrolling, northern bats typically fly away from the lights, being very difficult to spot from any direction and hidden from predators. Hence, even this presumably light-opportunistic species may avoid unnecessary exposure to bright illumination (Rydell 1986, 1991).

Figure 2.4. Illumination of historical buildings repels bats from roosting in large attics. Wroclaw Historical Centre, Poland 2017 (© J. Rydell).

2.4 Impact of exterior illumination on bat roosts in buildings

Aesthetic illumination of buildings has increased dramatically in Europe over the last 25 years. This is particularly true for churches, monasteries, castles, but also for old bridges, fortresses, towers and monuments (Fig. 2.4). Recently, the lighting of private houses, factories and other buildings has become a widespread practice. Conflicts between the human demand to illuminate such buildings and the protection of bat roosts are already apparent and expected to increase in future.

Numerous studies have reported negative effects of illumination on the persistence of bats inside the roost, on emergence timing, behaviour, foraging activity and on juvenile growth rates have been detected (Boldogh *et al.* 2007; Fuszara & Fuszara 2011; Zagmajster 2014; Kosor 2016; Kotnik 2016; Zeale *et al.* 2016).

Regardless of bat species, maintenance of dark areas is particularly important around the entrances to maternity roosts, because these places are used consistently by many individuals over the critical peri-

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ods of pregnancy, parturition and lactation. Maternity roosts are also places where the young learn to fly and where sit-and-wait predators such as owls or cats may pose a serious threat to bats (Downs *et al.* 2003). Therefore, special attention should be given to buildings with maternity roosts.

Short term effects. The effect of illumination on bat roosts has been studied for churches in several countries, ranging from Slovenia to Sweden and from the United Kingdom to Hungary. Although comparable studies for other types of buildings are missing, similar effects can be expected for constructions akin to churches.

Illumination of buildings with roosts exposes bats to increased predation risk, which in turn disrupts their emergence activity and results in deteriorating foraging opportunities. This applies especially to light-averse species such as *Rhinolophus* spp. and *Myotis* spp. (Boldogh *et al.* 2007; Zagmajster 2014; Kosor 2016; Kotnik 2016; Zeale *et al.* 2016), but also to bats of the genus *Pipistrellus* and *Eptesicus* that often feed opportunistically at lights (Downs *et al.* 2003; Fuszara & Fuszara 2011). However, the effects of ALAN on the emergence and activity patterns are also influenced by the presence of surrounding protective trees as well as the intensity, shading, direction and colour of the light close to the roost (Downs *et al.* 2003; Zagmajster 2014; Kosor 2016). When a colony may use several exits, illumination may affect bats differently. Overall, the magnitude of detrimental effects may be weaker when bats could use alternative unlit exits (Zagmajster 2014).

Bright illumination of roosts may cause a sudden decline in the number of emerging bats, as observed in a colony of notch-eared bats in Hungary (Boldogh *et al.* 2007). This decline could indicate that the bats either abandoned the roost or they were entombed inside and, in the latter case, may eventually starve (Zeale *et al.* 2016). Indeed, in several cases artificial illumination forced bat colonies to completely abandon roosts (Boldogh *et al.* 2007).

Long-term effects. Although long-term effects of illumination on bat colonies in buildings can be expected, there is only a single study addressing this topic by comparing colony presence in churches over a period of 25 years. In the 1980s, Rydell (1987) investigated 61 country churches in southern Sweden for the presence of *Pl. auritus*, before any floodlights were installed in this area. The same churches were then surveyed again in summer 2016, when about half of the churches had become illuminated at least partially (Rydell *et al.* 2017; Fig. 2.5). The percentage of churches with bat colonies had decreased by 38% in 2016 and all of the abandoned churches had been fitted with aesthetic lights (floodlights) in the period between the surveys, strongly suggesting that the illumination was causative for the disappearance of bats. Alternative explanations, such as renovations and targeted attempts to exclude bats from roosts, could be ruled out as a reason for colony collapses.

Bats were affected differently if churches were completely or only partly illuminated. For example, *Pl. auritus* were less often observed in churches that were illuminated

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from all directions, compared to those that were only partly illuminated (Rydell *et al.* 2017). Illumination of buildings from all directions may be particularly detrimental since bats have no dark exits to emerge from, and no dark flyways between the roost and the surrounding areas. In the churches that remained unlit, all colonies of *Pl. auritus* remained in the same place after 25 years, hence showing consistent site fidelity. This study clearly shows that, in the long run, floodlights pointed towards buildings can have a devastating effect on the bats that live in the illuminated building. A smaller decrease in colony numbers was detected when at least part of the building was left dark for the bats' emergence and return. In a three-year study on emergence behaviour of *R. hipposideros* at church roosts, researchers observed differences in the proportion of emerging bats in relation to the level of illumination at roost openings (Zagmajster 2014). A significantly higher proportion of bats exited at the belfry opening closer to the woodland when it was shaded, while when heavily illuminated, a higher proportion of bats used the darker opening directed away from the woodland (Zagmajster 2014).

Disappearance of bats from lit buildings may not be obvious over the short term, as bat colonies are unlikely to abandon favourable roosts quickly. Indeed, *R. hipposideros* and *Pl. auritus* may remain in lit buildings for some time, despite the detrimental effects of ALAN, owing to the bats' extraordinary site fidelity (Zagmajster 2014; Rydell *et al.* 2017). The observation that some of the long-eared bats consistently returned to partly lit churches may be a consequence of the limited number of

Figure 2.5. Three examples of churches in Sweden included in the 2016 survey of Rydell et al. *(2017). All had maternity colonies of* Plecotus auritus *in the 1980´s.* ***(A)*** *Bats remained in some of the partially illuminated churches, when they could leave from and return to the roost without having to pass through the light cone.* ***(B)*** *Bats disappeared from churches that were illuminated from all sides, without any dark passage left. In this case, lights were also installed inside, where the bat colony lived previously.* ***(C)*** *Bats consistently remained in churches that were not illuminated by flood-light. (© J. Rydell).*

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high-quality roosts for this species (RYDELL *et al.* 2017). Fidelity of *R. hipposideros* to illuminated roosts has been attributed to a trade-off between the disadvantage of increased predation risk at the lit sites and the advantage of having high-quality feeding grounds unaffected by ALAN in the surrounding environment (ZAGMAJSTER 2014).

2.5 Impact of interior illumination on bat roosts in buildings

Lights installed inside lofts or church towers occupied by bats have a detrimental effect on bat colonies, even if these lights are only dim. A colony of *Myotis nattereri* in England did not emerge from the roost inside a church for several days after it was experimentally illuminated. The experiment had to be stopped to avoid starvation of bats and the potential collapse of the colony (ZEALE *et al.* 2016). In Sweden, several colonies of *Pl. auritus* disappeared after the installation of light bulbs inside attics and church towers (RYDELL *et al.* 2017). In Slovenia, the monitoring of a nursery colony of *R. hipposideros* in a church attic revealed that bats avoided the part of the attic that was illuminated by the sun during the day and by ALAN through a roof window during the night (KOTNIK 2016).

2.6 Artificial light in underground roosts

Underground sites, such as caves, mines, drainage pipes and similar subterranean structures are crucial for European bats (MITCHELL-JONES *et al.* 2007). Some underground structures such as caves and mines are often open to the public, particularly tourists and therefore are frequently illuminated, but empirical studies on bats using illuminated underground roosts are scarce. *M. bechsteinii* refused to leave the interior of an underground mine after the installation of illumination at the entrance (KUGELSCHAFTER pers. comm., in ZEALE *et al.* 2016). As a general observation, bats rarely, if ever habituate to artificial lights in underground sites and likely desert illuminated parts of show caves. For instance, commercial use of Fourth Chute Cave in Quebec, Canada, resulted in abandonment of the largest hibernaculum of eastern small-footed Myotis *M. leibii* known at the time in eastern North America (MOHR 1972). High light intensities have the most detrimental effect on the activity of bats, when MANN *et al.* (2002) explored behavioural responses of a maternity colony of 1,000 Cave Myotis *M. velifer* at an underground site by experimentally exposing the colony to cave tours. However, it is usually impossible to disentangle the impact of artificial light in show caves from associated factors, such as noise and changes in temperature and humidity.

Figure 2.6. A root cellar in Latvia regularly used by hibernating brown long-eared bats. (© J. RYDELL, 2014).

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A special case may be the root cellars traditionally used in northern Europe for storage of potatoes and other root vegetables over winter. These cellars are also used by hibernating bats such as brown long-eared and northern bats (VINTULIS & PETERSONS 2014). Temporary illumination of the interior of such cellars by light bulbs is tolerated by bats, presumably because the light is switched on for only a few minutes at a time (Fig. 2.6), yet long-term or comparative studies on this topic have not yet been undertaken.

2.7 Commuting routes and feeding areas

ALAN may affect the ***commuting routes*** of bats. The effects of light on commuting *M. dasycneme* were experimentally studied by placing a strong lamp (1 kW) along existing ***commuting routes*** (KUIJPER *et al.* 2008). The artificial light reduced the percentage of ***feeding buzzes*** by more than 60%, although the abundance of insects tended to increase. Experiments at hedgerows at eight sites in southern Britain indicated that *R. hipposideros* reduced their activity in proximity of light sources (HPS lamps) and delayed the onset of commuting behaviour (STONE *et al.* 2009). The number of commuting bats declined even for bats on the dark side of a hedgerow, indicating that even low levels of light (in average 4.2 lx at 1.75m above the ground) have a negative effect on the commuting behaviour of this species (STONE *et al.* 2009). LED lights also reduced the commuting activity of *R. hipposideros*, even when the lights were dimmed to 3.6 lx at 1.7m above the ground (STONE *et al.* 2012).

Installation of ALAN had a substantial effect on the commuting behaviour of free-flying little brown bats (*M. lucifugus*). Apparently, ALAN prevented bats from flying into the illuminated area and made the flight situation more complex, resulting in a dramatic failure of orientation (MCGUIRE & FENTON 2010). Recent studies revealed that even *P. pipistrellus*, the most common bat species in European cities, avoids highly illuminate areas when commuting even though this species tolerate ALAN when foraging around street lights (ALDER 1993; LIMPENS *et al.* 1997; VERBOOM & SPOELSTRA 1999; HALE *et al.* 2015).

Street lights may have two principal effects on bat foraging. The first one is direct, as ALAN may repel light-averse bats from lit areas and restrict their use of commuting or feeding space. Indeed, rows of lights may form barriers which fragment the landscape and constrain flyways and therefore also the use of roosts and feeding grounds (STONE *et al.* 2009, 2015b; MATHEWS *et al.* 2015; ROWSE *et al.* 2016a; HALE *et al.* 2015). Street lamps along roads might also act as fatal traps by increasing bat mortality due to more frequent collision with vehicles, an aspect that awaits investigation (STONE *et al.* 2015a; FENSOME & MATHEWS 2016). The second one is indirect, as street lights may attract insects and thus influences availability and abundance of prey (see Chapter 2.1).

Generally, ALAN may be exploited by bats in diverse ways, depending on the species, as illustrated in Fig. 2.7. The smaller and more manoeuvrable species generally fly lower and closer to the light source, while the larger and faster species usually

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fly higher and cover wider areas. How the largest and fastest bats such as *Tadarida* spp. exploit urban areas at high altitudes is generally unknown, although there may be considerable activity of bats above city centres.

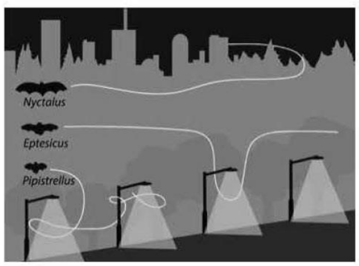

Figure 2.7. A general scheme showing how the size and wing shape relates to the way bats of different genera typically exploit a row of street lights. The smallest bats, e.g. P. pipistrellus, *normally use only one or a few lights at a time and spend some time in each light cone. Bats of the* genus Eptesicus *usually patrol the entire light row and make short and quick dives into the light cone in chase for insects, typically moths. Bats of the genera* Nyctalus *and* Vespertilio *are seldom seen in the light cones of small streetlamps, but occasionally at larger light sources, such as floodlights (© J. Eklöf).*

Stadiums, train stations, harbours and airports are often illuminated with very strong floodlights. There are early observations of bats hunting under floodlights of airports (Gould 1978), later confirmed for flood lights at stadiums (Schoeman 2015). Hunting for insects at such strong lights is observed in free-tailed bats (*Molossidae*) and sheath-tailed bats (*Emballonuridae*), particularly in the tropics. Such behaviour is also shown by other fast-flying species, *e.g.* the *V. murinus* and the *N. noctula* and *N. leisleri*.

Waterways, such as canals, streams and rivers, are important flyways and feeding sites for a diversity of bats. In particular, trawling mouse-eared bats, such as *M. daubentonii*, *M. dasycneme* and *M. capaccinii* are among the most light-averse bat species (Jones & Rydell 1994, Kuijper *et al.* 2008). Lighting of waterways and associated structures, *e.g.* valve bridges and locks, for aesthetic purposes may therefore have serious negative consequences for these species (Kuijper *et al.* 2008).

Drinking sites are important for a variety of bat species, particularly those in Mediterranean, semi-arid and arid areas, and probably for most or all female bats during lactation. Exposing these sites to ALAN has serious negative consequences for bats, almost regardless of species. Russo *et al.* (2017) illuminated ponds in Italy with a strong floodlight and found a negative effect on the drinking activity of all local bats, even on opportunistic species such as *P. kuhlii*. It is likely that bats at drinking sites are also affected when lighting levels are much lower. This applies not only to ponds in arid areas, but also to small bodies of water in forests. The widespread use of artificial lighting along rivers, canals or lake shores may therefore have severe consequences for bats and this fact should be considered whenever illumination of water bodies is planned or installed.

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2.8 Effects of ALAN on bat communities
ALAN causes species-specific responses (Rydell 1992; Stone *et al.* 2009; Lewanzik & Voigt 2017), which could cause displacement of species (Polak *et al.* 2011; Stone *et al.* 2015b). For example, a competitive relationship between two bat species that respond differently to ALAN may possibly drive changes in local bat populations (Haffner & Stutz 1984/85; Arlettaz *et al.* 2000). In extensively lit areas, the light-averse species of bats may disappear, at the same time the abundance of opportunistic species may increase when competition is reduced. In the long run, this effect may alter local bat assemblages (Ancilotto *et al.* 2015; Schoeman 2015).

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3 General aspects of the planning process

The increase of ALAN affects bats and ecosystems at various scales, reaching from local effects to regional or even global levels. Consequently, protective measures for bats should be integrated into planning and policy processes on all these spatial scales. Particularly, addressing the negative impacts of ALAN on bats (and other protected species) for all functional habitats should be a constituent and explicit part of national planning frameworks. The details of these measures should follow the principles of the mitigation hierarchy – starting with avoidance, then mitigation and lastly compensation (Chapter 5). To achieve this, at the national level the impact of ALAN should be incorporated in the state's ***Strategic Environmental Assessment*** (SEA) to detect environmental conservation problems in plans and programmes. The national implementation of ***SEA*** should then be included into regional and local plans and strategies.

Planning policies at the regional and local level deal with a broad range of issues, including economic development, transport, housing, environment and energy. Consequently, the plans and strategies at this level of governance have potential for adversely affecting the conservation status of protected species. The guidance produced for planning authorities at these levels of governance needs to address how to deal with conflicts between the provisioning of ALAN for humans and the conservation of our natural heritage. By considering possible conservation issues at an early stage in the planning process, conflicts between stakeholders can be avoided or reduced. At the regional or local level this should be achieved through ***Environmental Impact Assessment*** (EIA). GIS-based approaches (Fig. 3.1), ***e.g.*** the online application available at https://www.lightpollutionmap.info (Fig.3.2) may help to identify areas of potential conflicts. Guidance for carrying out ***EIAs*** around infrastructure construction or other developments should highlight the importance of standardised bat surveys that assess the potential impact of lighting schemes in a methodical manner and oblige developers to employ the mitigation hierarchy (Battersby ***et al.*** 2010). Where new lighting schemes are unavoidable, it should be mandatory to develop a lighting plan that considers the needs of bats and other wildlife so that a potential negative impact is avoided, or suitable mitigation and post-development monitoring schemes are put in place (Chapter 5).

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Impact zone of artificial lighting	Spatial scale	Planning tools for the consideration of lighting schemes
Migration routes (autumn/spring, long and short distance)	National and regional	• National environmental programmes/regulations; • Regulations/aims of national parks, biosphere reserves, nature parks, Natura 2000 sites • Regulations in national infrastructure projects • Regional conservation plans/landscape plans
Landscape	National and regional	
Commuting route	Regional and local	• Regional conservation plans/landscape plans • Management plans for protected areas (*e.g.* Natura 2000) • Guidelines for ecology assessments surveys • Guidelines for new buildings/developments/ refurbishment • Municipal regulations of o historic buildings o roads o private properties o sport facilities o advertisement o agriculture (*e.g.* greenhouses) o local conservation sites o management plans for caves, parks, green spaces, lakes
Feeding area	Local	
Roost (*e.g.* maternity, hibernation, swarming, mating)	Local	
	Local	

Table 3.1. Summary of spatial scale impacts and planning considerations.

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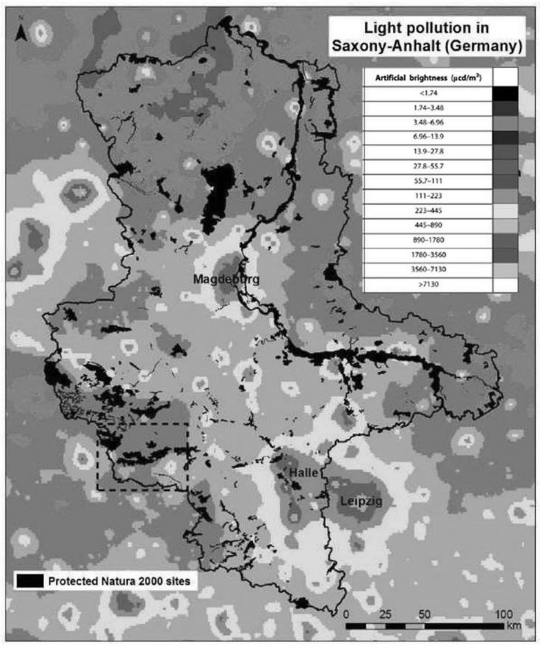

Figure 3.1. GIS map of the German state of Saxony-Anhalt showing Natura 2000 sites and ALAN for identifying zones of potential conflicts between light pollution and protected bat habitats. Dashed line indicates the area of Figure 3.2 (© K. Kuhring & M. Fritze, GIS layer source: F. Falchi et al. 2016).

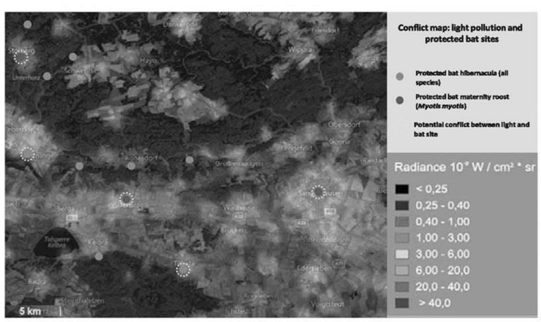

Figure 3.2. A map of the southern Harz in Saxony-Anhalt (local scale) showing protected bat hibernacula and maternity roosts of Myotis myotis *together with ALAN. Mapping may help to identify potential conservation conflicts (© K. Kuhring & M. Fritze, ALAN map source: https://www.lightpollutionmap.info).*

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4 Carrying out impact assessments

4.1 General aspects of monitoring and assessment schemes

The most important feature of monitoring schemes, regardless of taxa and context, is a sound research question based in ecological theory, that is tested using a standardised survey technique, with all external factors kept constant (or as close to constant as possible) except for the change in the relevant factor, ***i.e.*** ALAN. For the assessment of the effects of the impact of a change in lighting, this is typically a before-after treatment assessment, such as counting the number of bats emerging from a roost before and after illumination was installed. A Before-After-Control-Impact approach (abbreviated as BACI) may consider co-varying factors such as the season or the year when multiple factors may change with the light treatment (***e.g.*** Rowse ***et al.*** 2016b, 2018, Lewanzik & Voigt 2017). A standardized survey approach will ensure that other information required for interpreting the results, for example environmental conditions such as lunar cycle, ambient temperature, precipitation, is routinely recorded. More general aspects for surveillance and monitoring of bats can be found in the corresponding EUROBATS guidelines (Battersby ***et al.*** 2010). In the following, we will focus on specific aspects related to monitoring the impact of ALAN on bats.

4.2 When and where is monitoring important?

Monitoring is needed in all situations where bats are present and an installation or change in artificial light is planned. In some cases, the presence of bats may already be an established fact, especially for large roosts located in buildings, however ***commuting routes*** are usually unknown for these colonies. In most cases exploratory survey will be needed that target the planned change in ALAN. Changes may include the application of mitigation measures, the installation of new illumination, changes in the type of lamps or a modification of the lighting schedule (such as the duration of operation, or seasonal changes in lighting patterns).

Two situations in which the collection of data on the impact of ALAN on bats is particularly important are: 1) changes of ALAN at specific functional bat habitats such as roosts, ***commuting routes*** or ***foraging areas***, and 2) changes of ALAN on the landscape scale that could affect the ability of bats to access ***feeding areas*** and/or alternative roosts. Examples of the second case could include the illumination of river banks and roads.

4.3 Which data should be collected?

The following list provides a general guideline regarding the minimum level of data collection that should be conducted at each site.

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General guidelines

- Check whether measures are implemented correctly, in case of the application of mitigation measures;
- Use the same equipment wherever possible, with the same settings, before and after the lighting change;
- Be aware of, and record, additional changes in the vicinity of the location being monitored. For example, habitat alterations which may affect bat activity independent of the effect of lighting.
- Ensure that sufficient data are collected to consider temporal variation in bat activity, *e.g.* from day to day or across seasons. In the case of landscape surveys, automated static bat detectors should be used as these allow efficient data collection over multiple nights;
- The surveys conducted before and after changes to the lighting regime should be performed at the same time of year and in comparable weather;
- When conducting roost surveys, ensure that all exit points are monitored;
- For surveys in the wider landscape away from roosts, conduct surveys over a distance of at least 100 meters, incorporating areas at which the lighting will be changed. Paired control sites where the lighting regime is unchanged should always be included as part of the survey design: this is particularly critical in situations where a before-after comparison is not possible. For a detailed description of how to set up schemes for the monitoring of roosts, see section 3.3 in the EUROBATS guidelines (Battersby *et al.* 2010).
- Surveyors are encouraged to interpret the data they collect to identify patterns of use. For example, peaks of activity at dawn and dusk may indicate proximity to a roost.
- Differences in illumination should be measured and compared with original lighting plans.
- Light meters can be useful, but must be calibrated appropriately, and the same instrument should be used for before- and after-change measurements.
- Another option for quantifying illumination is to use a digital single-lens reflex camera (DSLR) on a tripod. Before and after the change in lighting, photographs should be made from the same spot, with the same DSLR, the same lens, and with the same ISO, image format, aperture, shutter speed and white balance settings (*e.g.* Lamphar *et al.* 2014).

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5 Avoidance, mitigation and compensation

As outlined before, ALAN directly affects bats in their activity at night. It is important to keep in mind that ALAN also affects the insects that they feed on. Thus, any consideration of lighting schemes should include both direct and indirect effects, *i.e.* via trophic interactions.

5.1 Avoidance

As a rule, ALAN should be strictly avoided, and artificial lighting should be installed only where and when necessary, *i.e.* when ALAN is needed for safety reasons or to comply with the legal framework. Through careful consideration prior to development of new infrastructure it is often possible to avoid illumination of bat habitats without putting human safety at risk. The protection of dark refuges is essential for bats, particularly in urban areas. Land-use planners and authorities should pay attention to the preservation of dark corridors between roosts and larger unlit, vegetated areas such as urban parks and gardens which might function as the ***feeding areas***. A network of dark corridors would allow bats to commute between roosts and feeding areas without exposure to direct illumination in a landscape that is otherwise fragmented by ALAN (Fig. 5.1). Particularly, in towns where vegetation is scarce and most of the soil is sealed, spatial planning of outdoor lighting and of a 'light-exclusion network', respectively, should be set up concomitantly with the planning of a green infrastructure network.

Dark corridors should provide protective vegetation cover, *i.e.* optimally a closed canopy, which helps bats as a leading structure when commuting. Vegetation cover could also provide shade from ***skyglow***. Bright paving materials, that reflects moonlight, help to reduce ALAN since roads and trails are better visible for humans in the twilight. New solar-charged light-emitting materials which could substitute the use of artificial lights at bike paths are being tested (Fig 5.2). Influence of such 'glowing paths' on wildlife has to be evaluated and compared with that of conventional lighting.

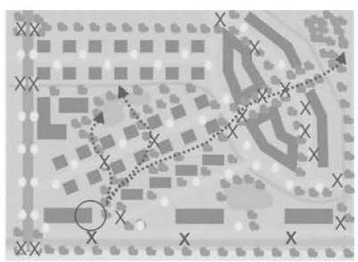

Figure 5.1. Schematic map of a village (dark grey: buildings; light grey: a small road; light blue: water bodies; brown: a large road; green-grey tree silhouettes: locations of trees). Bats emerge from a large building in the lower left corner (red circle) and commute (dashed green lines) along alleys to their foraging areas at a pond and in the forest. It is advised to avoid illumination or shield luminaries at the highlighted areas (red crosses) along treelines, waterbodies/channels and sites where treelines and channels cross the road (© H. Limpens).

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Figure 5.2. Example of a bicycle trail with a lighter paving material allowing to use it without street lights later in the evening (© H. LIMPENS).

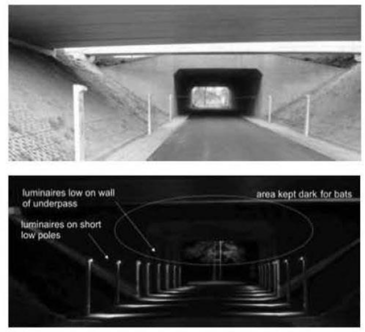

Figure 5.3. Installation of luminaires on short poles for mitigating the effect of ALAN on a commuting route through an underpass in the Netherlands (the same place in daylight and at night). This solution was proven as efficient for P. pipistrellus *but not for the low-flying species* M. daubentonii *(© F. BREKELMANS).*

When ALAN is needed for safety reasons, dynamic lighting schemes that are switched on only when needed should be considered. Dynamic lighting schemes are usually triggered via motion sensors by a pedestrian, bicyclist or cars.

Use a minimal number of lighting points and ***luminaires*** on low positions in relation to the ground for minimising ***light trespass*** to adjacent bat habitats or into the sky (Fig. 5.3).

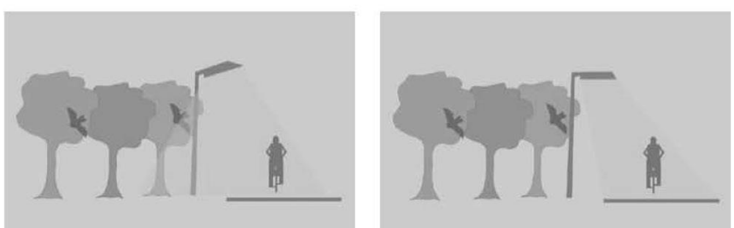

Figure 5.4. Avoidance of light trespass by installing shielded luminaries. Left – conventional luminaire with light spillage into the adjacent forest habitat, right – shielded luminaire that focuses the light cone only on the area where it is needed (© H. LIMPENS).

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Use focused light, ***e.g.*** by using LED or shielded ***luminaires*** which limit the light flux only to the required areas and prevent ***light trespass*** into adjacent bat habitats (Figs. 5.4 and 5.5).

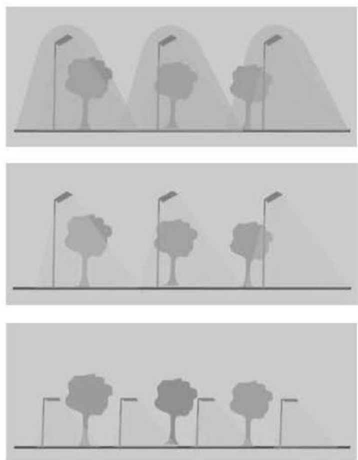

Figure 5.5. Combined effect of shielded luminaires and short poles on reducing light trespass. First picture - unshielded luminaires, second - luminaries with shields. The third picture shows shielded luminaires on short poles which cut-off light trespass and keep adjacent areas dark (© H. LIMPENS).

Create screens, either by erecting walls or by planting hedgerows or trees, to prevent ***light trespass***, ***e.g.*** from illuminated roads, to surrounding bat habitats. Screens can reduce the negative effects of ALAN on bats to some degree (MATHEWS ***et al.*** 2015; Fig. 5.6, 5.7).

Figure 5.6. In the Netherlands, walls were designed to avoid light trespass from a highway to a wildlife bridge with commuting routes (© H. LIMPENS).

Figure 5.7. Partially shielded noise screens, installed during the construction of a new motorway in the Netherlands for avoiding light trespass to a compensation area with bat habitats (© V. LOEHR).

Exits of bat roosts and a buffer zone around them should be protected from direct or indirect lighting to preserve the natural circadian rhythm of bats. Given that aesthetic light is not required for safety, arguments for such illumination should be reconciled with the need to preserve the nature and nocturnal organisms. Corresponding adjustments to existing artificial lighting should be made.

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The following prioritization for areas of conservation concern should be regarded when planning outdoor lighting:

P1: Protected areas (parks, natural monuments) including Natura 2000 sites

- Core zones of protected areas need strict avoidance of any external ALAN, except for inevitable purposes if required by a legal framework (safety). Mitigation measures (Chapter 5.2) must be considered and applied wherever possible.
- In buffer zones around the protected area only long-wavelengths luminaries should be allowed, which do not contribute significantly to ***skyglow***. In buffer zones, light pollution shall be minimised, and further lighting limited (Gaston *et al.* 2015). For unavoidable lighting, mitigation measures must be wherever possible applied. Any light in the buffer zone must be distant enough for ensuring that its ***illuminance*** level at the boundary of the protected area is lower than 0.1 lx, which roughly corresponds to the brightness of a full moon.

P2: Underground and overground roosts

- Strict avoidance of any direct artificial light inside the roost and at its entrances/exits. ***Illuminance*** levels caused by distant lights must be below 0.1 lx at the roost entrances, exits and along the emergence corridors outside the roost (measured by holding a luxmeter in a vertical position at 1.5 m above the ground, measuring perpendicular to the sky, or next to the roost entrance or exit).
- A flyway from the entrances/exits towards nearby unlit hedgerows, treelines or other structures used by bats for commuting must be kept unlit, with light levels below 0.1 lx. If possible, a preferable direction of emerging bats should be investigated beforehand, and the dark corridor accordingly outlined.

P3: Habitats that constitute key feeding areas of light-averse bat species, such as bodies of water (*e.g.* river banks, ponds, canals) and forests

- Strict avoidance of any direct ALAN. ***Illuminance*** levels due to distant lights must be below 0.1 lx.

P4: Habitats that are often used by bats for foraging and commuting, such as urban parks and gardens, the edges of forests, hedgerows and tree lines

- ALAN should be avoided whenever possible. Alternatively, partial lighting or dimming may be used to reduce the negative impact on foraging and commuting bats.

In summary, ALAN should be avoided wherever possible. For any unavoidable artificial lighting at night, adequate mitigation measures (see below) have to be considered and applied wherever possible.

5.2 Mitigation

Careful evaluations of the potential impact of light pollution on bats must be considered prior to any outdoor lighting projects. If artificial light is necessary for social, security or safety reasons, it is of major

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importance to adopt a "need-based" outdoor lighting planning strategy in order to illuminate only WHEN and WHERE it is actually required (KYBA *et al.* 2014). In this context, limiting the temporal and spatial extent of ALAN is a key issue for mitigating the adverse impacts of light pollution on biodiversity (including bats).

Outdoor lighting planning requires ALAN management through five integrated levels of action that emphasize 1) the spatial arrangement of artificial light sources to enhance connectivity between dark refuges for foraging and roosting in the landscape (see 5.1 Avoidance) and 2) its duration to illuminate only when it is necessary for humans (KYBA *et al.* 2014). Once areas and time periods that actually need to be lit have been defined, outdoor lighting planning should focus on 3) reduction of ***light trespass*** on nearby vegetation through precise directionality of the luminous flux; 4) reduction in the ***illuminance*** of light sources; and 5) adaptation of the spectral composition of the lamps according to the ecological context (GASTON *et al.* 2012; SCHROER & HÖLKER 2016). Outdoor lighting planning recommendations for mitigating the impact of ALAN on ***feeding areas*** and ***commuting routes*** are presented in Table 5.1.

5.2.1 Mitigating the impacts of ALAN on feeding areas and commuting routes

Limiting the duration of night-time lighting (part-night lighting schemes): Public outdoor lighting is responsible for a substantial part of local administration's energy consumption and electricity bills. Following the economic crisis of 2008, many rural administrations across Europe have therefore set up part-night lighting schemes by turning off public outdoor lighting from midnight (± 1 hour) to early morning (05-06 AM). Although these schemes have mostly been set up to reduce local electricity costs, they may effectively mitigate the adverse impacts of ALAN on bats as they allow restoring darkness at a landscape scale for several hours during the night. It may hence give light-sensitive species access to additional ***feeding areas*** and restore landscape connectivity for at least part of the night. However, nocturnal biodiversity is mostly active soon after sunset. Most insect biomass is available at dusk and peak of activity of Microlepidoptera occurs during the first two hours after sunset (KNIGHT *et al.* 1994; JETZ *et al.* 2003). As a consequence, nocturnal insectivores including bats follow the same pattern (JONES & RYDELL 1994; JETZ *et al.* 2003). Thus, current part-night lighting schemes appear to fail encompassing the range of activity of most bat species (AZAM *et al.* 2015; DAY *et al.* 2015). In this context, the dark phase of a lighting scheme must begin within the first 2 hours after sunset to capture more than 50% of nightly bat activity (Fig. 5.8; DAY *et al.* 2015). This would be crucial for bats during reproduction and migration. For an entire city or village, such a scheme would likely face resistance from local inhabitants (GASTON *et al.* 2012). However, the emergence of adaptive lighting technologies may open new opportunities for adopting specific part-night lighting schemes at landscape features where bats commute and forage.

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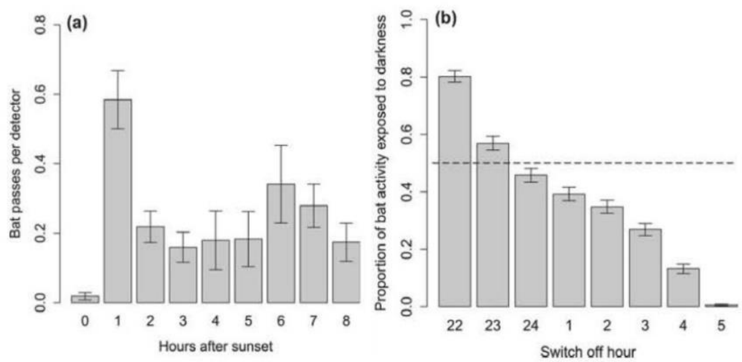

*Figure 5.8. Results of a study in the UK on the activity rhythm of greater horseshoe bats (*Rhinolophus ferrumequinum*) with (a) mean hourly bat passes (±se) across sites and (b) proportion of activity potentially exposed to dark conditions within part-night lighting scenarios. A dashed line represents 50% bat activity in the dark portion of the night (*DAY *et al. 2015).*

Dimming illuminance and limiting light trespass: for safety reasons, the European standard EN 13201 recommends illuminating pedestrian pathways and low-traffic roads with a minimum of 7.5 to 10 lx, and commercial areas and access roads with a minimum of 15 to 20 lx. These guidelines conflict with bat conservation as light-sensitive bats avoid areas exposed to even lower ***illuminance*** values (KUIJPER *et al.* 2008; STONE *et al.* 2012; LACOEUILHE *et al.* 2014; LEWANZIK & VOIGT 2017). Furthermore, many bat species show lunar phobia and reduce foraging and commuting activities during full-moon nights (SALDAÑA-VÁZQUEZ & MUNGUÍA-ROSAS 2013). In this context, it is important to stress again that exposure to ***illuminance*** as low as full moon (*i.e.* 0.1 lx) may already have a negative impact on bats. Thus, it is probably impossible to define an ***illuminance*** threshold that is compatible with both security standards and conservational requirements. However, the night-time light pollution is often exacerbated by poor lighting designs that emit light in upward and horizontal directions and induce ***light trespass*** (GASTON *et al.* 2012). The trespass may impact significant amounts of natural and semi-natural vegetated patches (MARCANTONIO *et al.* 2015). Therefore, reducing ***light trespass*** may effectively limit impacts of light pollution on biodiversity, and simultaneously decreasing electricity consumption.

FALCHI *et al.* (2011) provide practical recommendations for limiting light pollution in outdoor lighting:

1. Dim light according to actual human usage of a given area to avoid overly illumination. This is particularly relevant for

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commercial and industrial areas which are often brightly lit (HALE *et al.* 2013).

2. Use fully shielded ***luminaires*** that have no light emitted above the horizontal.
3. Direct downward light flux only toward the area that needs to be lit. Correcting a luminaire's height can help to focus light and avoid pollution.

These recommendations should help to avoid the vertical illumination of important bat ***commuting routes*** and ***feeding areas*** such as forest edges and hedgerows. Furthermore, controlling luminaires' height could also allow darkness restoration in the upper canopies of trees.

Finally, it is important to note that light reflected from lit surfaces can also induce significant upward light emissions and hence light pollution. For example, in Lombardia, Italy, although 75% of the artificial sky brightness is produced by light escaping directly from fixtures, 25% of it is induced by the reflections off lit surfaces (FALCHI *et al.* 2011). Thus, replacing light-reflective surfaces by light-absorbent ones could be an effective way to reduce ***light trespass*** (GASTON *et al.* 2012).

Limiting the short wavelength (UV and blue) content of the light spectrum: In the EU, the most widely used types of light sources for streetlamps are sodium vapour lamps (HPS and LPS), MH and HPMV lamps representing 37, 36, and 27% sales, respectively, for the period 2004-2007 (EUROPEAN COMMISSION 2011). However, since the European Eco-Design Directive (245/2009) became effective, HPMV lamps are being progressively phased out because of their low energetic efficiency (Table 5.1). This change occurs concomitantly with the increased cost-effectiveness of energy-efficient LEDs, representing so far approximately 7% of the European market (ZISSIS & BERTOLDI 2014). HPMV, MH and standard white LED lamps often have broad-spectrum emissions, with an important peak of energy in the blue range and Correlated Colour Temperatures (CCT) > 3000 K.

Short wavelength emissions in the blue and UV ranges are responsible for the "flight-to-light" behaviour of billions of insects (VAN LANGEVELDE *et al.* 2011) (see Chapter 2.1). During their search for insects, fast-flying aerial-hawking bats such as *Pipistrellus* spp. are therefore more attracted to MH and HPMV than to sodium lamps and white LEDs (STONE *et al.* 2015a; LEWANZIK & VOIGT 2016). However, although blue and UV emissions may offer foraging benefits for some bat species, they raise environmental concerns as they control melatonin secretions in mammals (FALCHI *et al.* 2011, SCHROER & HÖLKER 2016) and likely induce long-term population declines in insect communities (CONRAD *et al.* 2006). Furthermore, blue and UV emitting light sources may attract insects from adjacent dark habitats, and thus may lower the quality of these adjacent habitats for bats (EISENBEIS 2006, chapter 3). In this context, it is important to avoid streetlamps emitting "cold-white" light containing wavelengths below 540 nm and with a CCT > 2700 K. It is important to point out that UV light is useless in street lights since it cannot be perceived by humans. Hence, wavelengths in the UV range can be filtered without any decrease in ***illuminance*** level. In contrast to humans, many bats can per-

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ceive UV light (ZHAO *et al.* 2009, FUJUN *et al.* 2012, GORRESEN *et al.* 2015). For them, light sources emitting UV waste light presumably appear brighter than light sources with longer wavelength spectra. Consequently, UV-emitting lamps are particularly disturbing for light-averse bats and filtering the UV part of the spectrum may mitigate the effect of ALAN on them.

Nevertheless, it is important to note that slow-flying light-sensitive species such as *Myotis* spp. and *Rhinolophus* spp. avoid illuminated areas regardless of conventional lamp spectra. Negative effects of artificial lighting on their activity have been reported for HPMV (LEWANZIK & VOIGT 2016), HPS (STONE *et al.* 2009; AZAM *et al.* 2015b), and white LEDs (STONE *et al.* 2012). This evidence supports the hypothesis that there are no "bat-friendly" conventional lamp types. Specifically designed light sources can however be an alternative. For example, deterrence of slow-flying bats (*Myotis* spp. and *Plecotus* spp.) and artificial attraction of agile species because of insect attraction (*e.g. Pipistrellus*) in foraging habitat can be avoided by using light with a reduced amount of blue, and an increased amount of red in its spectrum (SPOELSTRA *et al.* 2017).

Excluding any unwanted effects of any light type or spectrum remains difficult, and it is therefore important to state that darkness is always preferable. However, streetlamps with a pronounced blue content such as "cold-white" LEDs or MH significantly increase light pollution on a landscape scale because blue light is more easily scattered in the atmosphere than green and red lights (FALCHI *et al.* 2011). A simulation of a transition from HPS outdoor lighting to white LEDs (4000 K) across Europe revealed a 2.5-fold increase in night sky brightness perceived by a human dark-adapted eye (*i.e.* FALCHI *et al.* 2016). Thus, broad spectrum lamps emitting a substantial proportion of their energy in the short wavelength range are likely to exacerbate nightscape fragmentation and induce landscape-scale loss of dark refuges for bats.

New lighting technologies – opportunities and threats: We are currently witnessing an important development in outdoor lighting management as most existing lighting infrastructure is reaching its end-of-life in Europe. In the meantime, the increased cost-effectiveness of LEDs which are highly energy-efficient and have good luminous efficacy, will likely engender an exponential deployment of this technology in outdoor lighting in the coming decade (ZISSIS & BERTOLDI 2014). As with many technological innovations, LEDs not only offer opportunities to limit light pollution, but also potent to increase it (STANLEY *et al.* 2015). On the one hand, they can allow light to be directed with unprecedented precision and dimmed, via central management systems, according to human rhythms of activity throughout the night over large scale (KYBA *et al.* 2014). The potential of the adaptability of the spectrum of LEDs can be further explored to reduce impact on natural systems and be used to optimize light for different social contexts. Accordingly, this technology can offer promising options to design outdoor lighting schemes that can limit both the spatial and the temporal extents of ALAN and restore dark-

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ness integrity in human-inhabited landscapes. On the other hand, the massive deployment of LEDs in public infrastructure may come with a "rebound effect", characterized by both 1) the introduction of new artificial light sources in previously unlit areas, and 2) the use of brighter and often "cold-white" street lights (KYBA *et al.* 2014, 2017). Therefore, an ecological expertise of outdoor lighting projects will be particularly crucial in the coming decades to ensure that this technological innovation does not increase light pollution (emissions). Additional information on outdoor lighting recommendations can be found on the COST "Loss of the Night Network" website (http://www.cost-lonne.eu/recommendations/).

	Measure	Recommendations
Avoidance	*Conserve dark areas*	High priority areas that should remain dark: • protected areas, including roosting and underground hibernation sites • feeding areas (natural areas, vegetation patches) • commuting routes (forest edges, hedgerows, rivers, tree lines)
Only if lighting is necessary, and after an assessment of bat occupancy and patterns of activity within the landscape framework of functional habitats:		
Mitigation	*Part-night lighting*	Turn off public outdoor lighting within **2 hours after sunset** (civil twilight): • Especially during bat reproduction and migration periods • Particular attention within home ranges of maternity colonies
	Dimming	• Adapt dimming strategy to human activities • Keep illuminance levels as low as possible according to EU standards (not going over minimum illuminance required)
	Avoid light trespass	Avoid light trespass over 0.1 lx on surrounding surfaces: • Use fully shielded luminaires • No illumination at or above horizontal • Control street light height, especially along pedestrian pathways and tree lines • Use fewer light sources at points low to the ground • Consider the interaction between light from luminaires and reflecting structures, such as roads and walls
	Adapt lamp spectra	Avoid lamps emitting wavelengths below **540 nm** (blue and UV ranges) and with a correlated colour temperature > 2700 K
Compensation	*Restore dark areas*	No net loss of darkness: • Restore darkness to the same extent as the proportion of dark areas lost • Enhance alternative dark corridors that connect roosts and feeding areas

Table 5.1. Synthesis of the outdoor lighting planning recommendations to limit the impacts of ALAN on bat feeding areas and commuting routes.

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5.2.2 Mitigating the impacts of artificial lighting on bat roosting sites

It is paramount to completely avoid artificial illumination at bat roosts. The mitigation measures should be applied only when compelling arguments are present, as absolutely "bat friendly" illumination is impossible (MOHAR ***et al.*** 2014). The proposed mitigation measures should not be regarded as equal alternatives to avoidance, but only as actions with diverse levels of effectiveness for bat conservation. ALAN at bat roosts may originate from sources situated either inside (***e.g.*** in caves or church interiors) or outside the roosting structure (***e.g.*** external illumination of cultural heritage buildings, or natural rocky walls).

Artificial light outside of bat roosts (see Chapter 2.4): ALAN in front of a roost can affect the evening emergence behaviour and impact ***commuting*** bats (BOLDOGH ***et al.*** 2007; STONE ***et al.*** 2009, 2012). This impact can be reduced by installation of screens or masks that exclude the surfaces with flight openings, and that are directed on the walls of a building to reduce or avoid ***light trespass*** to the environment (MOHAR ***et al.*** 2014). Similarly, light sources illuminating a tree roost exit could be equipped with a shield, which prevents direct illumination of the exit and attributed ***commuting routes***. Wherever exits are already indirectly illuminated, the ***light trespass*** on such surfaces should be stopped. The effectiveness of such measures was studied in a project in Slovenia, on some roosts of ***R. hipposideros*** (MOHAR ***et al.*** 2014). If a church was illuminated by exaggerated light intensities and light spilled on some flight openings, more bats left the roost from those flight openings that were left dark (ZAGMAJSTER 2014). When masks that shaded the illumination of flight opening were installed, bats started to use the shaded flight openings.

Seasonal part-time lighting refers to controlling the illumination according to the season when the roost is occupied by bats. Some churches in Slovenia are lit with external illumination only during the most important religious events, like Christmas and Easter, while during the rest of the year the illumination is switched off. As bats inhabit such churches only during the time of nursery colonies, such a roost can be regarded non-illuminated from the bat perspective (ZAGMAJSTER & HERCOG, submitted).

Seasonal effects of human impact on bat roosts are more common at places that are visited by tourists throughout specific seasons. For example, the Predjama cave in Slovenia, one of the most important bat hibernation sites in Slovenia (PRESETNIK ***et al.*** 2009) is not visited by tourists during the winter. In the case of the Ajdovska jama cave in south east Slovenia, tourist visits and illumination of the cave interior is prohibited in summer, due to the presence of a Mediterranean horseshoe bat (***Rhinolophus euryale)*** nursery colony (PRESETNIK 2004).

The timing of external illumination may also be adjusted on a daily basis. For example, Slovenian guidelines recommend that the illumination should be switched off after 23.00 hours (MOHAR ***et al.*** 2014). This proposal was made mainly to provide enough time for night active moths to leave their resting places near the lights and con-

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tinue their life cycle, although any effect of this proposed timing on bats was not specifically studied. At least, in case of *R. hipposideros*, *Plecotus macrobullaris* and *Eptesicus serotinus* bats left the roost also under illuminated conditions, but with a delayed emergence time (Zagmajster 2014; Zagmajster, unpublished data). However, switching the lights on later in the night can present a new light barrier when bats return to the roost; especially when mothers return to feed the juveniles. However, there is no empirical evidence that a temporary illumination scheme is less impairing for bats than continuous lighting. Therefore, the regime of part-time lighting should be avoided in favour of total darkness (Boldogh *et al.* 2007) or evaluated before applied on a larger scale.

Artificial light inside bat roosts (see Chapters 2.5, 2.6): Internal illumination of roosts may occur both in buildings (both at the above- and underground level) and natural underground sites (*e.g.* caves). When lights are installed close to bat roosts, *e.g.* in the attics of a church, they are often used only during the visit of maintenance staff. In such cases, if unavoidable, only weak and highly directed light sources should be installed inside buildings or other structures with roosts. It should only provide sufficient light for short term visits by humans, but without trespass to the spaces below the roof and on roost entrances (see also Boldogh *et al.* 2007). Bats may become trapped in the roost in case lights would have accidentally left on (*e.g.* Kugelschafter unpublished, referred to in Zeale *et al.* 2016).

Any internal lighting (including that of hand-held torches and headlamps) as well other as disturbances due to visits shall be avoided at underground sites with either maternity or hibernation roosts. As show caves are sometimes large and complex, tourist trails should guide visitors in a distance from sensitive parts used by bats. Such parts must not be illuminated under any circumstances. A smart lighting design can be applied in show caves, *e.g.* by directing light only at specific cave formations. To avoid ***light trespass*** when illuminating the footpaths, only directional or low path lighting should be used. There are many examples where larger subterranean sites are split into illuminated parts for tourists and dark parts for bats, which show how the conflict between economic interests and conservation requirement can be reconciled. For instance, fortifications in Nietoperek (Poland) and abandoned limestone mines in Mönsted and Daugbjerg (Denmark) have been split into dark and lit parts, with latter ones opened for tourists. Part-time lighting in caves may also represent an effective method to mitigate the effect of interior lights on bats, *i.e.* illumination is only switched on when visitors are present. However, the evidence is lacking whether this scheme might aid bats inside the cave. Further, artificial light in caves can be dimmed to low intensities since the human eye will adjust to these low light levels over time (Mohar *et al.* 2014).

5.2.3 Adjusting light spectra

Little is known about the wavelength-specific response of light receptors in European bats and less so about the light spectra that affect their behaviour most severely.

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However, different light spectra can have different effects on the emergence behaviour of bats (Downs *et al.* 2003; Fig. 5.9). Compared to no artificial illumination, red light had the least effect on number of emerging *Pipistrellus pygmaeus* from two roosts while the number dropped significantly when the roost exits were illuminated with blue and white light (Downs *et al.* 2003). Red light was proposed for being used in bat roost checks, supposedly having least effect on bats (Downs *et al.* 2003). A recent study (Spoelstra *et al.* 2017; see Fig. 5.10) showed that reducing the blue and increasing the red part of the spectrum of a light source significantly mitigates its impact on slow-flying *Myotis* and *Plecotus* species in their foraging habitat. Conversely, the absence of blue light reduced the attraction of insects and thereby the attraction of agile, opportunistic species such as *Pipistrellus* spp.

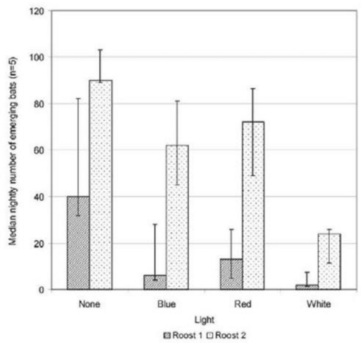

Figure 5.9. The median number of emerging P. pygmaeus *with different light treatments for two roosts (plus IQ range) (Downs et al. 2003: the difference was insignificant between the red-light and no-light treatments).*

Voigt *et al.* (2018) observed an increase in flight activity for migrating ***P. pygmaeus*** and a trend for a higher activity for ***Pipistrellus nathusii*** around red LED lights, which is unrelated to foraging and could be explained by phototaxis. Therefore, response of bats to light spectra modifications may differ during migration season and seems site and species specific.

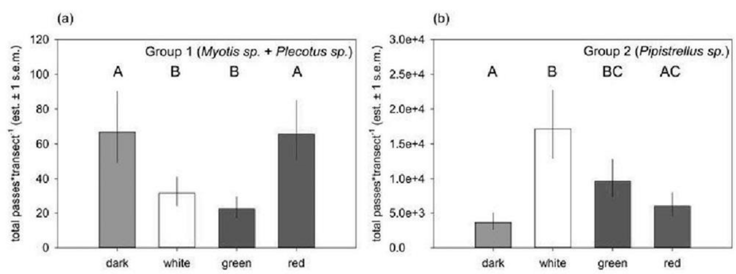

*Figure 5.10. Bat activity under four (permanent) lighting conditions (darkness, white, green, and red light) measured over the course of five years in forest edge habitat (model estimates). Group 1 includes slow-flying light-averse species (*Myotis *and* Plecotus *spp.); Group 2 includes opportunistic, agile* Pipistrellus *species. Capitals identify significant differences between groups in post-hoc tests (figure from Spoelstra et al. 2017).*

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	Roosts		
		External illumination of building facades	*Internal illumination of caves and other roosts*
Avoidance	*Conserve dark areas*	Bat roosts should not be illuminated.	Underground roosts (natural or anthropogenic) with hibernating bats and nursery colonies should be kept dark. Tourist visits should be forbidden in such sections.
Only if lighting is considered necessary, and after an assessment of bat occupancy and emergence behaviour:			
Mitigation	*Directional light, avoid light trespass*	Smart lighting onto only specific architectural parts: • surfaces and facades with flight openings must not be illuminated; • luminaires with shades to limit trespass on roost entrances; • directed (controlled) light – no trespass above horizontal.	Smart lighting design only: • low path lighting; • light only on selected speleothems.
	Part-time lighting	Only in season when the roost is not occupied. Evening illumination delayed, or lights switched off after critical time period (when needed for human safety).	Temporary lighting only when tourists are present (*e.g.* for emergency exit signs). Sector lighting of interior, light switched off when tourists not present.
	Dimming	Low intensity (below 0.1 lx)	Low intensity
	Adapt lamp spectra	> 500 nm	> 500 nm
Compensation	*Restore dark areas*	Priority roosts should be strictly protected and not illuminated. Provide alternative roosts nearby.	Provide dark chambers and dark flight tunnels.

Table 5.3. Synthesis of the lighting planning recommendations to limit the impacts of artificial lighting on bats in roosts.

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5.2.4 Mitigating indirect effects of ALAN on bats prey

For mitigating the impacts of ALAN on insects, it appears of major importance to limit the amount of blue and UV emissions in outdoor lighting by favouring warm colour temperature lamps (such as low-pressure sodium lamps or amber-LEDs). However, it is important to note that long wavelengths are as attractive as short ones to geometrid moths (Somers-Yeates *et al.* 2013), and that the negative effects of ALAN on moth reproduction was detected regardless of the lamp colour spectrum (van Geffen *et al.* 2015b). Thus, the enhancement of dark corridors and patches in human-inhabited landscapes seems to be a key strategy to effectively limit adverse impacts on biodiversity, including insects (Gaston *et al.* 2012). Outdoor lighting should be separated by at least 25m from vegetated areas, and by at least 40m from riverbanks to limit its effects on insects (Perkin *et al.* 2014; Degen *et al.* 2016). The attraction radius of street lights to moths also suggests that standard inter-street light distances (approximately 20 – 45m) should be broadened without a concomitant increase in light intensity to allow individual dispersal and increase landscape connectivity (Degen *et al.* 2016). Furthermore, particular attention should be given to dimming and orientating street lights for avoiding ***light trespass.***

Finally, although most dipteran and microlepidopteran activity is highest during the first few hours after sunset (Knight *et al.* 1994; Jetz *et al.* 2003), some taxa of macromoths are active much later at night (*i.e.* peak of activity at midnight; Rydell *et al.* 1996). Because of their large eye size, they appear to be more attracted to ALAN than micromoths, which may result in a size-dependent mortality of moths at street lights (van Langevelde *et al.* 2011). Hence, restoring darkness in human-inhabited landscapes for a part of the night, by turning-off street lights from around midnight to morning hours when traffic and human activities resume (*i.e.* part-night lighting schemes) may effectively limit the adverse impacts of artificial lighting on large moth species, which in turn may positively affect the bats that feed on them (such as *Plecotus* spp.; Azam *et al.* 2015).

5.5 Compensation

Compensating the impacts of ALAN on feeding areas and commuting routes: A "No Net Loss of Darkness" approach should be adopted when planning new outdoor lighting projects. These efforts should be paired with a decrease in light emissions from existing illuminated areas in order to halt the yearly increase in night sky brightness over Europe (Falchi *et al.* 2011; Bennie *et al.* 2014b). The extent of ***feeding areas*** and ***commuting routes*** impacted by ALAN should be quantified for restoring the same amount of dark refuges and corridors in alternative areas. These areas should be located nearby outdoor lighting projects, so that the impacted bat population can benefit from these compensation measures.

Compensating the impacts of ALAN on bat roosting sites: Bats use roosts year after year, and some species do not accept new alternative roosts in the vicinity easily (*e.g.*

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ZEALE *et al.* 2016). For this reason, it is very difficult to formulate compensation measures for the loss of roosts caused by ALAN. Therefore, the known important roosts in buildings should not be illuminated, or mitigation efforts employed. The same applies to caves and other natural roosts. Alternative dark roosts could be offered, but the effectiveness of these measures should be monitored.

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6 Research priorities

We have already collated substantial knowledge about various detrimental effects ALAN has on bats, yet the effects of ALAN are multifaceted and may be long-term. Therefore, we need further research. It is important to collate and analyse reports and single case studies to draw broader conclusions about the effect of ALAN on bats. Here, we propose some directions for future investigations.

6.1 Fitness consequences

Since bats have a low reproductive rate, it is particularly important to understand higher-level responses of bat species to ALAN. Besides a recent study from Sweden on declines in colonies of *Pl. auritus* (Rydell *et al.* 2017), no other long-term studies, covering several decades, have been carried out to determine if any of the observed behavioural changes in response to ALAN have consequences for fitness of bats. Although a potential effect of different illumination schemes on juvenile growth of *R. hipposideros* was studied in Slovenia at three roosts, observed differences could not be unambiguously related to differences in light regimes (Kotnik 2016). Boldogh *et al.* (2007) reported growth rates of juvenile bats in illuminated and dark roosts and interpreted the differences as a result of illumination. However, Kotnik *et al.* (2017) emphasized that multiple factors can influence reproductive success in a complex manner, and attention should be paid to disentangle the effect of illumination from other factors that may affect juvenile growth. Overall, we need to better understand how ALAN affects critical population parameters such as sex ratio, birth rate, dispersal and survival to understand and predict population-level effects.

6.2 Impacts on bat communities

The current literature highlights that ALAN may cause species-specific responses, which could alter the competitive interactions of bat species. For example, decreases in *R. hipposideros* numbers have been linked to increases in *P. pipistrellus* populations in Switzerland. It was suggested that growing, due to the improved food availability at recently installed streetlights, population of *P. pipistrellus* outcompetes and displaces that of *R. hipposideros* (Arlettaz *et al.* 2000). Further studies are needed to address the impact of artificial lighting on bat communities (Davies *et al.* 2013).

6.3 Emerging lighting technologies – spectra

Given the rapid technological advances outdoor lighting, research on how novel light sources may impact bat activity and reproduction are urgently required. Such studies should use sufficient replicates and a controlled design to generate meaningful data. One such example is the "Lichtopnatuur project" in the Netherlands where the effect of white, red and green LED lighting on various taxa is studied on a large spatial scale (Spoelstra *et al.* 2017; see http://www.lichtopnatuur.org).

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6.4 Bat vision

To improve our ability to predict the response behaviour of bats, it is key to better understand the spectral sensitivity of bat vision. Determining spectral and intensity thresholds for different species would aid to improve mitigation strategies and conservation initiatives (Gaston *et al.* 2013).

6.5 Efficiency of mitigation

Part-night lighting: some initial research has been performed in this area (see Chapter 5.2), but more studies must be done across a broader geographical range to encompass more species.

Motion detection: the dynamic lighting schemes, *e.g.* via the use of motion detectors, have already been implemented in Portugal, the Netherlands and France, and may have ecological benefits. The lights remain switched off unless needed, and so still provide all the perceived public safety benefits (Royal Commission on Environmental Pollution 2009). However, these fluctuations in lighting levels may also be damaging to bats and should be studied.

Light trespass: Currently, it is largely unknown how bats respond to efforts for minimizing the ***light trespass***.

Dimming: More research needs to be launched to improve our ability to define the optimal light intensities that serve both purposes human safety and nature conservation.

Dark zones: effectiveness of dark areas and corridors for bats should be more thoroughly investigated.

Spectrum adjustment: further studies on the impact of altered spectra are essential, for example at various roost types, ***commuting routes*** and on different bat species.

6.6 Measuring light objectively

Illumination is measured in ***lux***, which is defined as the brightness of a light according to human spectral sensitivities; spectral sensitivities of other taxa are often very different from ours. Since the unit is commonly used by lighting engineers, designers and environmental regulators, migrating from this term may thwart interdisciplinary communication (Longcore & Rich 2004). Although outdoor lighting is usually installed for humans and hence measuring light in ***lux*** is a logical approach, this unit lacks key biological information.

6.7 Migration

Migratory animals are particularly sensitive towards anthropogenic changes because they depend on a serious of intact habitats. Some migratory birds are known to get distracted by ALAN, particularly in the red wavelength spectrum. Indeed, a recent study highlights that migratory *P. nathusii* might as well get disoriented, when exposed to artificial green or red light (Voigt *et al.* 2017, 2018), yet the underlying causes and any potential interference of ALAN with the navigational system of bats are still under debate and require further research.

6.8 Hibernation

The effects of lighting on bat hibernation are currently not known: field observations are contradictory and anecdotal. Given the importance of hibernation for the survival of many temperate species, this is an area which requires urgent attention. Key questions include the impacts of lighting on arousal and overwinter survival.

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6.9 Developing a predictive framework at the landscape level

Predicting areas where bats may be most at risk from light pollution will allow planning, avoidance and mitigation on larger scales. Development of methods and techniques for such predictions is crucial for conducting SEAs and EIAs.

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8 Glossary

Commuting routes – flight paths that bats use regularly to fly from a roost to a foraging area (and back) or to move between foraging areas or roosts.

Environmental impact assessment (EIA) – a national procedure for evaluating the likely environmental effects of those public and private projects which may have significant effects on the environment (see for instance Council Directive 85/337/EEC).

Feeding areas – habitat patches where bats perform area-restricted foraging.

Feeding buzzes – stereotypic sequences of echolocation calls indicating an insect hunt.

Illuminance – the total luminous flux per unit area; previously called brightness.

Habitats Directive – Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

Light trespass – artificial light in areas where it is not wanted; spill light.

Luminaire – a lighting unit.

Lux – a measure for the illuminance (lumen per square meter) as perceived by humans, derived from the international system of units (SI).

Migration – regular, usually seasonal, movement of all or part of an animal population to and from a given area.

Mitigation – action taken to mitigate, reduce or minimize any negative environmental impact such as habitat loss, animal fatality or injury where it is not possible to avoid such impacts.

Photic entrainment – adjustment of circadian rhythms by light.

Skyglow – brightness of sky caused by artificial light at night.

Strategic environmental assessment (SEA) – procedure for integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development (see for instance Directive 2001/42/EC).

Swarming – "autumn swarming" is a behaviour of some temperate bat species (particularly *Myotis*, *Plecotus*, *Eptesicus* spp. and *B. barbastellus*) that occurs from late summer to autumn. *Pl. auritus* performs a "spring swarming" as well. Bats may travel many kilometres to underground "swarming sites", arriving several hours after dusk, flying in and around the site and departing before dawn. Swarming is important part of social interactions, including courtship. Some swarming sites may also be used as hibernacula later in the year. Swarming ("dawn swarming") also refers to the circling flight pattern of some bat species that occurs outside the entrance to a roost (especially maternity roosts) before the bats enter at dawn.

LAA-19
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LAA-19
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UNEP

EUROBATS

EUROBATS

Eighty percent of the world's population are currently exposed to light-polluted skies, and the Milky Way is no longer visible to more than a third of humanity. The pace the light pollution is increasing is faster than global population growth and economic development. While environmental conditions at night are being dramatically and rapidly altered, circadian rhythms, behaviour and ecology of plants and animals are imminently influenced. In the same time, effects of artificial lighting, various illumination schemes and spectra on biodiversity, including bats, are currently insufficiently understood, whereas only a vague notion of required mitigation and compensation activities exists among decision-makers and other parties involved in lighting projects. Although the bats are almost exclusively nocturnal and extremely sensitive to multiple effects of light pollution, its negative impact on bats alongside essential measures needed to preserve unfragmented nightscapes for these animals are often disregarded during impact assessments, planning and operation.

In this volume, we tried to compile available evidence related to the effect of artificial light at night on the European bats. Based on the current state of knowledge, solutions are proposed concerning possible ways to avoid, mitigate and compensate the adverse effects which lighting projects may have on bats and their functional habitats. We also outlined research priorities for future studies, required for in-depth understanding of the problem and assessing efficiency of proposed mitigative measures.

These guidelines were developed by the EUROBATS Advisory Committee in collaboration with external experts in pursuance of Resolution 7.13 on Implementation of the Conservation and Management Plan.

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LAA-19
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2.3.2.1 Response to Letter from Los Angeles Audubon Society

Comment No.	Response
LAA-1	The commenter notes the history of the Los Angeles Audubon Society (Audubon) and the importance of La Brea Tar Pits and the Page Museum. The County would like to thank the commenter for participating in the public review process of the Draft EIR. A copy of this comment letter will be included in the Final EIR, which will be provided to the Board of Supervisors for review when the project is considered for approval. This is not a comment on the Draft EIR; therefore, no response is necessary.
LAA-2	The commenter opines that the project will result in a loss of open undeveloped space and that the project would result in the overdevelopment of the site. While this is not a comment specifically on the analysis contained in the EIR, it should be noted that the vast amount of parkland provided by the 13-acre Hancock Park will continue to serve as a park facility within Los Angeles. As proposed, the Master Plan would retain and enhance more than 90 percent of the existing open space and passive park use of the site. As well, as described in the EIR Project Description, while the project would require removal and replacement and/or relocation of between 150 and 200 trees on the project site, there are more than 330 trees currently at the project site. The planting strategy includes the introduction or relocation of a similar number of trees as would be removed. As a result, the final number of trees at the site is anticipated to be increased rather than decreased after implementation of the project. New plantings would be consistent with the planting and landscape concept and plant palette included in the La Brea Tar Pits Master Plan. New plantings would be selected for resilience to disease and with consideration for their ability to create shaded areas at the park. No changes to the EIR were determined to be necessary in response to this comment. Refer to **MR-1, Preferred Alternative, MR-2, Impacts to Native and Mature Trees,** and **MR-3, Use of Native Plants and Vegetation,** for more information.
LAA-3	The commenter expresses concern over the number of trees that would be removed from the site, and also provides the opinion that people and wildlife need parks with fewer buildings, not more. As discussed in EIR Section 5.12, Recreation, implementation of the project would not impede public access to Hancock Park and impacts to recreation would be less than significant. While the project would not expand or increase the amount of area dedicated to existing passive recreational uses, it would include improvements to the existing recreational areas and outdoor open spaces through modification to the existing pedestrian pathways into a continuous paved pedestrian path linking the existing elements of the site, including the Central Green. The project would also add a children's play area, picnic areas, and other new passive recreational amenities, such as seating areas and viewing points. No changes to the EIR were determined to be necessary in response to this comment. Additionally, refer to response to comment LAA-2.
LAA-4	The commenter indicates concern with hazards to birds related to the materials that may be used for the development of the new structures and development at the site. Also, the commentor refers to a prior project, "the construction of a large glass cube at Exposition Park in 2013", which it is the Otis Booth Pavilion located at the Natural History Museum site in Exposition Park. The illustrations and images provided in the Master Plan and Chapter 3, Project Description, of the EIR were not intended to imply the use of a specific type of material or amount of glass surface to be incorporated into the project design; they are conceptual illustrations and were developed early in the Master Plan design process. The following language has been added to Chapter 3, Project Description (added text shown in underline): "<u>To reduce the risk of birds striking or colliding with the building, new construction would include deterrent features on glass barriers, windows, and building elements likely to present imperceptible barriers for avian species. These features would include ceramic frit patterns and/or other features that meet the criteria from the American Bird Conservancy for bird friendly glazing.</u>" The County will continue to refine the project designs to decrease the extent of glazing and the need for bird deterrence. As more detailed construction documents are developed, appropriate bird deterrence methods will be studied and incorporated further to significantly reduce bird strikes resulting in mortality or injury. After receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including Audubon, and refined the design of the improvements proposed at the La Brea Tar Pits site. As a result, the County has proposed of a variation of the Master Plan which is described in the Final EIR. Refinements to the project will continue to be considered by the County as the design evolves. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information provided by the updated designs and Refined Alternative 3. The Otis Booth Pavilion at the Natural History Museum site (900 Exposition Boulevard, Los Angeles) is not part of the proposed project. The Pavilion was originally built so that the upper portion of the glass structure featured a bird strike reduction frit; however, the lower portion of the Pavilion did not. In Spring 2023 a pattern was added to the lower part of the Pavilion using solutions provided by a vendor specializing in bird deterrent technology solutions that are endorsed by bird conservation organizations and an overall decrease in bird collisions was noted after implementation.
LAA-5	The commenter indicates that the large expanses of glass that characterize the new facilities are inherently dangerous to birds and that birds cannot perceive glass as a barrier and will try to fly through these walls of glass and windows.

Comment No.	Response
	Refer to response to comment LAA-4. It should also be noted that, after receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including Audubon, and refined the design of the improvements proposed at the La Brea Tar Pits site. The County has proposed of a variation of the Master Plan which is described in the Final EIR. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information provided by the updated designs and Refined Alternative 3. As indicated in response to comment LAA-4, new construction would include bird collision deterrent features. This clarification has been added to EIR Chapter 3, Project Description. Furthermore, the current design approach has significantly decreased the extent of glazing. Refined Alternative 3 significantly reduces the glazed area above the terrace level in the expansion, and the glazed atrium that replaced the Page courtyard has been eliminated. Therefore, implementation of the project would not significantly increase the potential for bird collisions.
LAA-6	The comment states that the project's plans to illuminate the new glass facade would increase the chance of bird collisions. Refer to response to comment LAA-4 and LAA-5. It should also be noted that, after receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including Audubon, and refined the design of the improvements proposed at the La Brea Tar Pits site. The County has included a variation of the Master Plan in the Final EIR. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information provided by the updated designs and Refined Alternative 3. There are not significant components of the project that would result in lighting from within the new museum building. As well, like existing conditions, there are no plans for projection of images onto the walls or surfaces of the buildings. As discussed in EIR Section 5.1, implementation of Mitigation Measures AES/mm-4.1 and AES/mm-4.2 would reduce light and glare impacts to less than significant. These measures would ensure that the project would not substantially worsen the existing lighting conditions of the site. Through on-going management and operation of the property, the County will ensure that lighting from within is reduced to the extent feasible while retaining enough lighting for security and safety needs. This commitment is made for both existing and new facilities. The new museum building is not anticipated to be lit from within to any greater degree than the existing Page Museum. Lighting from within will be limited to dim security lighting, like the existing conditions at the Page Museum. No significant change in the amount of lighting from within buildings would occur. The new museum building would close at 5 pm, as the Page Museum closes now. Thus, no change in the timing of building illuminations would occur. Therefore, implementation of the project would not significantly increase the potential for bird collisions.
LAA-7	The commenter compares the project's plans to illuminate the new glass facade with the Wilshire Federal Building in Westwood, where bird collision and mortality has been documented. Refer to response to comments LAA-4, LAA-5, and LAA-6. This is not a comment that raises issue with the contents of the environmental analysis in the EIR; therefore, no response is necessary, and no changes to the EIR were determined to be necessary in response to this comment.
LAA-8	The commenter provides additional feedback on the renderings in EIR Chapter 3, Project Description, specifically related to the pathway that is planned to cross the lake. The commenter provides reference to a prior project, the Otis Booth Pavilion, and presents an article indicating that this prior project was not bird friendly. Refer to response to comments LAA-4, LAA-5, and LAA-6. As indicated in LAA-4, new construction, including the pathway features over the Lake Pit, would include bird collision deterrence features. This clarification has been added to EIR Chapter 3, Project Description. The County will continue to refine the project designs to decrease the extent of glazing and the need for bird deterrence. As more detailed construction documents are developed, appropriate bird deterrence methods will be studied and incorporated further to reduce bird strikes resulting in mortality or injury. It is expected that simply based on the design, the project would result in fewer bird collisions than the Otis Booth Pavilion. Compared to the Otis Booth Pavilion, the proposed project would result in significantly less glass surfaces. The Otis Booth Pavilion is six-stories tall and has an exterior that has three sides that are mostly glass. In comparison, the new museum building that is being proposed would be two stories tall and would feature an exterior consisting of only limited glass surfaces. Since construction of the Otis Booth Pavilion, new methods have been employed to reduce bird collisions with the building, such as adding patterned dots or stripes to the windows. The project would implement similar methods to minimize bird collisions. Furthermore, as indicated in response to comment LAA-4 and LAA-5, the current design approach has significantly decreased the extent of glazing. Refined Alternative 3 significantly reduces the glazed area above the terrace level in the expansion, and the glazed atrium that replaced the Page courtyard has been eliminated. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information provided by the updated designs and Refined Alternative 3. Implementation of the project would not significantly increase the potential for bird collisions.
LAA-9	The commenter requests that LEED bird collision deterrence guidelines be adopted for both the building and the glass pathway railings. The County may consider relying on the LEED bird collision deterrence guidelines; however, these specific features will not be finalized until the project design is complete. Further, it should be noted that adherence to LEED bird collision deterrence guidelines is not necessary to address potential impacts related to avian

Comment No.	Response
	collisions. As indicated in response to comment LAA-4, new construction, including the pathway features over the Lake Pit, would include deterrent features. This clarification has been added to EIR Chapter 3, Project Description. The County will continue to refine the designs as the project develops to reduce the potential for bird collisions as much as possible. No changes to the EIR were determined to be necessary in response to this comment.
LAA-10	The commenter opines that proper mitigation is necessary because millions of birds migrate over the City of Los Angeles each spring and fall and they are attracted to lights and mortality. The commenter indicates that birds of concern include sensitive species and migratory songbirds as a sensitive group, which have declined precipitously since the 1970s. The commenter claims that construction of the new facilities would constitute an impact through disturbance of migratory pathways for migratory birds and through impacts to migrants that winter in Los Angeles, such as Yellow-rumped Warbler, Townsend's Warbler, and Hermit Thrush, and that these species need not be rare or endangered to merit consideration under CEQA. The commenter goes on to opine that CEQA requires the consideration of impacts to native wildlife and mitigation for these species, as asserted in a recent ruling regarding the Sidewalk Repair Program EIR prepared by the City of Los Angeles for a City project. In response, some background on the City's Sidewalk Repair Program is warranted and is provided here. The Sidewalk Repair Program proposed to streamline the sidewalk repair process across the entire City of Los Angeles, with the City allocating roughly $1.3 billion towards sidewalk repairs over a 30-year period. These sidewalk repairs that were proposed included the following: installation of missing curb ramps, repair of damage caused by street tree roots, upgrade of existing curb ramps, repair of uneven pavement, and widening of pedestrian rights of way. If implemented, the project would result in the removal of an estimated 12,860 street trees. While the commenter claims that the recent ruling indicates that CEQA requires the consideration of impacts to native bird species, this does not appear to reflect the scope of the decision specifically made by the court (United Neighborhoods for L.A. v. City of L.A. Superior Court of California, County of Los Angeles, March 14, 2023, Case No. 21STCP02401) (Sidewalk Repair case). It is important to point out that Superior Court decisions are not considered citable case law. Published or "citable" opinions of the appellate courts are opinions ordered published in the Official Reports and may be cited or relied on by other courts and parties. The Sidewalk Repair decision is not legally binding precedent. However, to provide a response to this comment, some aspects of the Court decision that could relate to the subject matter of the La Brea Tar Pits EIR and this Audubon comment are reviewed below. In the Sidewalk Repair decision, the Court noted that it is undisputed that the Sidewalk Repair Program would affect certain bird species, including sensitive species. However, the Petitioner disagreed with the City that the EIR provided a proper and legally adequate analysis of the impact. As raised by petitioners and agreed to by the Court, the issue in the Sidewalk Repair case concerns the City's the analysis of the project's impacts to birds other than sensitive species. As indicated by the court: • "An EIR may not set an impermissibly narrow threshold of significance for biological impacts. (Endangered Habitats League, Inc. v. County of Orange (2005) 131 Cal.App.4th 777, 792; see also Guidelines, § 15064, subd. (b)(2). ["Compliance [*14] with the threshold does not relieve a lead agency of the obligation to consider substantial evidence indicating that the project's environmental effects may still be significant."]) If evidence tends to show that the environmental impact might be significant despite the selected threshold in the EIR, the agency must address that evidence. (Protect the Historic Amador Waterways v. Amador Water Agency (2004) 116 Cal.App.4th 1099, 1111.) And: • "CEQA mandates that public agencies consider short term impacts as well as long term impacts of a project. (Guidelines, § 15126.2, subd. (a). ["Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects."]) However, the County did not limit its analysis to sensitive species. As provided for in EIR Section 5.3, Biological Resources, impact question (d), the EIR addresses effects of the project on non-sensitive species. Further, additional clarifying text has been added to the EIR to expand upon this consideration of non-sensitive species. The evaluation of biological resources for the La Brea Tar Pits Master Plan, including birds, included research of publicly available biological reports and spatial data from a variety of online sources, geospatial databases, and relevant previous reports for the project site and vicinity, for sensitive and non-sensitive species. In addition, a field survey was conducted to document species present or with potential to be present that included wildlife, regardless of their sensitivity. Several non-sensitive and non-native species were observed, or noted for potential to occur, such as rock dove, European starling, house finch, yellow-rumped warbler, urban rats, and eastern fox squirrel. Further, an analysis of potential nesting bird habitat in the project area was conducted per the federal Migratory Bird Treaty Act. The list of migratory birds covered by the act includes nearly all bird species native to the United States, regardless of sensitivity. Native wildlife, including sensitive and non-sensitive status species, are considered in the thresholds of significance based on the Environmental Checklist (contained in Appendix G of the State CEQA Guidelines) per question (d), "would the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites." Refer to pages 5.3-24 through 5.3-26 of EIR Section 5.3, Biological

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	Resources for more information. This discussion in the EIR has been expanded in this Final EIR to provide more information on all bird species, regardless of sensitivity status. It should be noted that no “significant new information” has been identified because of these changes. These revisions only clarify and support the discussion regarding impacts to non-sensitive species included in the Draft EIR. As no significant modifications have been made, recirculation of the EIR is not required.
	The County is not asserting that other wildlife species are unlikely to occur at the project site nor that the project site is heavily disturbed; the particular circumstances of the La Brea Master Plan project are significantly different that those of the citywide Sidewalk Repair Program. The size and scale of the La Brea Master Plan project is considerably smaller and more focused than the Sidewalk Repair project, the former taking place solely within a 13-acre site, and would be completed within 4 years, while the latter takes place across the entire City of Los Angeles and would take place across the span of 30 years. The number of trees to be removed by each project differs as well; the implementation of the La Brea Master Plan would result in the removal and replacement and/or relocation of just 150 to 200 trees, while the Sidewalk Repair Program would result in the removal of an estimated 12,860 trees. Further, the Sidewalk Repair Program would specifically remove street trees, which, as discussed in Wood 2020 cited by the commenter, are particularly favored by avian species, and provide important habitat where there might otherwise be none. The La Brea Master Plan project would not remove any street trees, and instead would be removing and replacing trees within an existing green space. Many trees would remain in place throughout construction of the project and would continue to provide habitat for any number of species.
	As indicated in Section 5.3 of the EIR, page 5.3-25, the project site is suitable for permanent habitation:
	    There is potentially suitable nesting bird habitat present on-site and within 500 feet of the project site boundaries in street trees and landscape vegetation. The nesting season is generally defined as January 1 to September 15. Construction conducted during this period could result in adverse impacts to nesting birds. Temporary impacts to nesting birds would result from the removal of existing mature trees and shrubs during project construction. Although many more trees would be added than are proposed for removal, it would take several years for newly installed trees to reach the size and structural complexity of existing trees.
	    During project operation, indirect impacts could result from increased visitation use to the park and required maintenance of updated park facilities during nesting bird breeding season. Indirect impacts may also include beneficial impacts from an overall increase in native trees and shrubs associated improvement of native habitat for local bird species. Additional and higher-quality habitat for wildlife would be incorporated into site design that would improve conditions for birds and other wildlife over existing conditions.
	Further, the commenter does not substantiate why they believe the circumstances of the City's Sidewalk Repair Program should be compared to the La Brea Tar Pits Master Plan project. While both projects would result in the removal of trees which could potentially impact local bird species, as noted above, the Sidewalk Repair Program includes the removal of 12,860 trees across Los Angeles, which is several magnitudes larger than the 150 to 200 trees proposed for removal or replacement by the proposed project.
	For all the reasons noted above, impacts to non-protected bird species by the implementation of the La Brea Master Plan would be considerably less than the impacts posed by the Sidewalk Repair Program. Regardless, additional text has been added to the La Brea Master Plan EIR which expands the analysis of impacts to non-protected bird species. See EIR Section 5.3, Biological Resources, pages 5.3-24 and 5.3-25.
	As noted by the commenter, an urban oasis, such as the La Brea Tarpits, in dense cities provide important stop over habitat for sensitive and common California native bird species such as the Yellow-rumped Warbler (identified in the project site during surveys), Townsend’s Warbler, Hermit Thrush, and others. The implementation of the La Brea Tar Pits Master Plan, depending on final design, could provide less refugia for migrating bird species in the immediate project site temporarily. However, birds are highly mobile and would likely use the significant urban tree refugia immediately north of the project site and numerous city parks and golf courses within 2 miles. For example, there are eBird recordation of 66 bird species at Park La Brea, located immediately north of the La Brea Tarpits, and 81 species recorded at Pan Pacific Park located less than 0.4 miles to the north. In addition, significant open space within the Hollywood Hills and Santa Monica Mountains are located 3 to 5 miles to the north and west with a large number of street trees and small parks in the interspaces. Over the longer term, the habitat in the project area for migratory and native nesting birds, both sensitive and common, is anticipated to increase three to five years following construction, as the native plantings (which replace the removed trees) mature. These native plantings are much more desirable to native bird species than exotic and ornamental species. The landscaping palette will incorporate native trees, shrubs, and herbs, providing a layered habitat that provides structure for a larger variety of native species than currently present. The temporary relatively small loss of trees relative to intact tree resources surrounding the project site and the implementation of nesting bird mitigation and replacement of plantings with native planting would reduce impacts to less than significant. Additionally, implementation of Mitigation Measure BIO/mm-5.1 would aid in the avoidance of impacts to nesting birds.
	The County acknowledges the source cited by the commenter, Horton et al. 2019, which provides evidence that the generation of significant artificial light during the night can pose risks to migratory birds. However, as previously discussed, no significant change in the amount of lighting from within buildings would occur because of the project. Therefore, implementation of the project would not significantly increase the risk for bird collisions due to artificial light. Refer to response to comments LAA-6 for further information regarding the potential impacts to birds because of lighting generated by the project.
	The County also acknowledges the source cited by the commenter, Rosenberg 2019, which provides evidence demonstrating the wide-spread decline of bird species across North America, partially due to

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	reduction in habitat. However, the project would not permanently reduce the habitat area for birds. As previously discussed, replacement of non-native trees and vegetation with native species would improve the overall quality of bird habitat in the park and would provide habitat that is expected to increase the number and diversity of birds using the park. Birds, and particularly native bird species, are known to avoid areas dominated by non-native tree species. With an increase in native tree species and other native vegetation, birds would be more likely to nest in the trees and shrubs on the project site. A diversity of native shrubs and trees would also increase the variety of plant structure (plant height, width, and foliage type) that would also improve bird habitat quality over existing conditions. These native trees and shrubs are also more resilient and likely to survive and thrive over the long term as they are uniquely adapted to the local southern California climate and are known to offer better-quality resources such as food, nesting and roosting opportunities, and protection from predators. While the necessary tree removal proposed by the project may result in a temporary reduction in bird occurrence and viable habitat, the cumulative impact of the new native trees and plant species would eventually increase the amount of bird habitat supported by the site. Replanting of trees should result in no temporal loss of habitat for those individuals, while planting of new native shrubs should provide habitat within 2 to 3 years and trees in 5 to 10 years. As concluded in BIO Impact 1, the implementation of the La Brea Tar Pits Master Plan could result in significant effects on one species, the federal candidate monarch butterfly, either directly or through habitat modifications. Specifically, impacts during project construction could be significant. However, implementation of BIO/mm-1.1 would reduce construction impacts to any candidate, sensitive, or special-status species to less than significant. During project operation, the project would not result in significant effects, either directly or through habitat modifications, on any identified candidate, sensitive, or special-status species. Impacts during project operation would be less than significant. Similarly, no significant impacts to non-sensitive species are expected to result due to implementation of the La Brea Tar Pits Master Plan. Typically, for significant impacts to occur to non-sensitive species, it would require a greater quantifiable impact relative to that of impacts to sensitive species. This occurrence results from the fact that sensitive species, by definition, are designated as rare by a regulatory or advisory agency with expertise in the population levels and habitat threats of the species. Therefore, relatively small impacts to those species have greater proportional impacts to the species at a population level than a similar scale impact to a non-sensitive species. In order to demonstrate a significant impact to non-sensitive species, it generally necessitates documentation that a project will affect the species in such a way to markedly change the population level, such as shifting a stable population to a decreasing population. Examples of ecologically significant impacts could include the destruction of rookery or nursery habitat, the obstruction of a migratory artery, or the destruction of foraging habitat such that the population is no longer able to reproduce at replacement levels. None of these impacts would occur as a result of the project. Implementation of BIO/mm-5.1 and BIO/mm-5.2 would reduce construction and operation impacts to nesting birds to less than significant. Mitigation Measure BIO/mm-5.1 addresses the avoidance of impacts to nesting birds and BIO/mm-5.2 provides for the introducing of large box trees to reduce temporal impacts to bird habitat. Implementation of BIO/mm-5.1 and BIO/mm-5.2 will ensure that the tree removals will be conducted in a manner that is minimally impactful to nesting birds. Given that the tree canopy is projected to be fully replaced within 5 to 10 years of the project, no long-term losses of habitat for non-sensitive species are expected.
LAA-11	The commenter suggests that the project should have considered expanding the Page Museum vertically, instead of constructing a new museum building. An expansion of the Page Museum vertically could not occur without creating more significant impacts to the historic Page Museum. This is the reason that the County elected to propose a second museum building. By largely retaining the Page in its current configuration, the integrity and historic quality of the Page can be protected, and impacts reduced. For this reason, the County has determined that this design alternative would not be feasible and would not meet the project's objectives. Further, an EIR shall only describe a range of reasonable alternatives to the project which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project. An EIR need not consider every conceivable alternative to a project. The option proposed by the Audubon would be detrimental to the integrity of the Page Museum from a historic standpoint. While this option could potentially result in the removal of fewer trees, many trees would still need to be removed due to the other on-site improvements proposed by the project. It should also be noted that, after receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including Audubon, and refined the design of the improvements proposed at the La Brea Tar Pits site. The County has included in the EIR a variation of the Master Plan for consideration by the Board of Supervisors. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information provided by the updated designs and Refined Alternative 3.
LAA-12	The commenter indicates that the EIR should identify the removal of 150 to 200 trees as a significant adverse impact on wildlife. The proposed removal of trees at the La Brea Tar Pits site is not considered a significant impact on the environment. The environmental analysis regarding vegetation and tree impacts that is contained in EIR Section 5.3, Biological Resources, is an accurate assessment of the potential for significant environmental impacts regarding tree and vegetation removal. It should be noted that the project would result in an increase in the number of native trees at the project site. These native trees are more resilient and likely to survive and thrive over the long term as they are uniquely adapted to the local southern California climate. No

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	changes to the EIR were determined to be necessary in response to this comment. Refer to **MR-2, Impacts to Native and Mature Trees**.
LAA-13	The commenter states that the EIR does not include adequate bird surveys to sufficiently demonstrate the project's potential for impacts on native bird species. The comment goes on to list 97 native birds that may be present on the project site. As indicated in response to comment in LAA-10, implementation of the La Brea Tar Pits Master Plan would not result in significant effects, either directly or through habitat modifications, on any identified candidate, sensitive, or special-status species. Similarly, no significant impacts to non-sensitive species are expected as a result of the project. Typically, for significant impacts to occur to non-sensitive species, it would require a greater quantifiable impact relative to that of impacts to sensitive species. This occurrence results from the fact that sensitive species, by definition, are designated as rare by a regulatory or advisory agency with expertise in the population levels and habitat threats of the species. Therefore, relatively small impacts to those species have greater proportional impacts to the species at a population level than a similar scale impact to a non-sensitive species. In order to demonstrate a significant impact to non-sensitive species, it generally necessitates documentation that a project will affect the species in such a way to markedly change the population level, such as shifting a stable population to a decreasing population. Examples of ecologically significant impacts could include the destruction of rookery or nursery habitat, the obstruction of a migratory artery, or the destruction of foraging habitat such that the population is no longer able to reproduce at replacement levels. None of these impacts would occur as a result of the project. The California Natural Diversity Database (CNDDB) RareFind application and United States Fish and Wildlife Service (USFWS) occurrence data were used for background research as these sources are reviewed by regulatory agencies before occurrence data is reported. CNDDB RareFind is only used for identifying the presence of special status species on a project site and is not meant to be used for identifying the presence of non-special status species. Further, as discussed in LAA-10, additional text has been added to the La Brea Master Plan EIR which expands the analysis of impacts to non-protected bird species. See EIR Section 5.3, Biological Resources, pages 5.3-24 and 5.3-25. The evaluation of biological resources for the La Brea Tar Pits Master Plan, including birds, included research of publicly available biological reports and spatial data from a variety of online sources, geospatial databases, and relevant previous report for the project site and vicinity, for sensitive and non-sensitive species. In addition, a field survey was conducted to document species present or with potential to be present that included wildlife, regardless of their sensitivity. Several non-sensitive and non-native species were observed, or noted for potential to occur, such as rock dove, European starling, house finch, yellow-rumped warbler, urban rats, and eastern fox squirrel. Further an analysis of potential nesting bird habitat in the project area was conducted per the federal Migratory Bird Treaty Act. The list of migratory birds covered by the act includes nearly all bird species native to the United States, regardless of sensitivity. The results of this search identified two special status bird species, Southern California rufous-crowned sparrow (*Aimophila ruficeps canescens*) and coastal California gnatcatcher (*Polioptila californica ssp. californica*), with historic records within a mile of the site. The report further analyzed the habitat in the project site to support these and other special status bird species. Species detection during the survey was limited to time of year that the surveys occurred and the short duration of the survey period. In comparison, the data found in eBird was collected over a more than 10-year period. The eBird data does indicate that the project area and its surroundings may be refugia for many native bird species. However, it should be noted that birds are highly mobile, and the birds identified in the eBird listing included in the comment likely also use the significant urban tree refugia immediately north of the project site and numerous city parks and golf courses within 2 miles. For example, there are eBird recordation of 66 bird species at Park La Brea, located immediately north of the La Brea Tarpits, and 81 species recorded at Pan Pacific Park located less than 0.4 miles to the north. In addition, there exists significant open space within the Hollywood Hills and Santa Monica Mountains, 3 miles north and 5 miles west, respectively, with a large number of street trees and small parks in the interspaces. A reference to the eBird results in relation to special-status species has been included in Section 5.3.1.2 through this Final EIR (Table 5.3-4). However, this additional data does not alter the results of the analysis or required mitigation measures for the project.
LAA-14	The commenter notes that the list provided in comment LAA-13 includes sensitive species, species in decline, and indicator species of the oak woodlands and wetland habitats found at the site. Oak woodlands, riparian habitats, and other aquatic resources were located at the project site and mapped; these habitats can support sensitive bird species. The exact trees or areas to be impacted through implementation of the project have not yet been determined and avoidance would occur, where feasible. Mitigation Measures BIO/mm-2.1 and BIO/mm-3.1 provide for the preparation and implementation of an approved restoration plan that will provide replacement habitat at an equal or better value than the existing within 5 years of planting. In addition, Mitigation Measure BIO/mm-5.1 addresses the avoidance of impacts to nesting birds and BIO/mm-5.2 provides for the introducing of large box trees to reduce temporal impacts to bird habitat. If oak trees cannot be avoided, Mitigation Measures BIO/mm-6.1 provides for the replacement of oaks at a 2:1 ratio for each tree impacted. No changes to the EIR were determined to be necessary in response to this comment.
LAA-15	The commentor indicates that the EIR is inadequate in its assessment of impacts on birds and should find that the removal of 150 to 200 trees is a significant adverse impact on the bird community at this site. The

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	commenter further opines that replacement of trees would be an inadequate mitigation measure because the design reduces the habitat area for birds considerably and species number is closely tied to habitat area. The County disagrees that the project would reduce the habitat area for birds. As proposed, the Master Plan would retain and enhance more than 90 percent of the existing open space and passive park use of the site. As well, while the project would require removal and replacement and/or relocation of between 150 and 200 trees on the project site, there are more than 330 trees currently at the project site. The planting strategy includes the introduction or relocation of a similar number of trees as would be removed. As a result, the final number of trees at the site is anticipated to be increased rather than decreased after implementation of the project. Further, replacement plantings would be primarily native species, and the project would increase the number of native trees at the project site. Replacement of non-native trees and vegetation with native species would improve the overall quality of bird habitat in the park and would provide higher quality habitat that is expected to increase the number and diversity of birds using the park. Many species of birds, and particularly native bird species, are known to avoid areas dominated by non-native tree species. With an increase in native tree species and other native vegetation, birds would be more likely to nest on site. A diversity of native shrubs and trees would also increase the variety of plant structure (plant height, width, and foliage type) that would also improve bird habitat quality over existing conditions. These native trees and shrubs are also more resilient and likely to survive and thrive over the long term as they are uniquely adapted to the local southern California climate. In addition, impacts to sensitive riparian habitats in the project area, which contain extremely valuable bird habitat, would be fully addressed through the mitigation measures identified in the EIR, which provide for restoration, enhancement, and management of new riparian habitat over a five-year period. Mitigation measures for impacts to habitat areas are provided for in Mitigation Measures BIO/mm-2.1, BIO/mm-3.1, BIO/mm-6.1 and BIO/mm-6.2. The mitigation measures identified in the EIR are adequate to address potential impacts; no changes to the EIR were determined to be necessary in response to this comment.
LAA-16	The commenter opines that the EIR provides a lack of reporting on the presence of bat species at the project site. The commenter references an article titled "We Found Bats at La Brea Tarpits!" from nhm.org published in 2014, as well as a Life History Account for the Pallid Bat prepared by CDFW. To support the EIR analysis, the CNDDB RareFind application and USFWS occurrence data was used for background research as these sources are reviewed by regulatory agencies before occurrence data is reported. The results of this search identified no bat species recorded within 5 miles of the project site in over 30 years. The 2014 nhm.org article "We Found Bats at La Brea Tarpits!" was also reviewed. Four species of bats were identified using bat detectors, although these records had not been uploaded to the CNDDB. Lastly, email correspondence with Miguel Ordeñana (the author of the 2014 article) indicated that the Hoary bat (Lasiurus cinereus) has also been observed on the project site. A discussion regarding impacts to bats has been added to EIR Section 5.3. The following text has been added on page 5.3-8, and 5.3-9, regarding existing conditions of the site: "Initial background database reviews did not indicate known bat presence at, or within the vicinity of the project site and no CNDDB records less than 30 years old were found within 5-miles of the site. Additionally, during the initial reconnaissance survey on March 18, 2022, no species of bats nor obvious signs indicating potential bat roosts, were detected within the project area. The project site includes open water features which may present suitable foraging habitat and nearby trees which may provide suitable roosting habitat for some bat species. A 2014 Los Angeles Natural History Museum of Los Angeles County article, authored by Miguel Ordeñana, indicates that the following four species of bats were positively identified during field acoustic monitoring surveys between July and September 2014: big brown bat (Eptesicus fuscus), canyon bat (Parastrellus hesperus), Mexican free-tailed bat (Tadarida brasiliensis), and Yuma myotis (Myotis yumanensis) (Foundation 2014). The article does not elaborate on the nature of bat detection, neither indicating if the bats were actively foraging, roosting, or were detected flying over the project site. Based on the habitat requirements and habits of these species, it is likely that these bats are transient foragers of the project area. Further email correspondence with Miguel Ordeñana indicated that the Hoary bat (Lasiurus cinereus) has also been observed on the project site. None of these species are listed under the CESA or the ESA and of the five species discussed, only the Yuma myotis and the Hoary bat occur on the CDFW Special Animals List. Yuma myotis has a NatureServe Global rank of G5 (Secure; at very low risk of extinction due extensive range, abundant populations or occurrences, and little to no concern from declines or threats) and State Rank of S4 (Apparently secure; uncommon but not rare; no immediate conservation concern). The Hoary bat has a NatureServe Global rank of between G3 (Vulnerable; At moderate risk of extinction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors) and G4 (Apparently secure; at fairly low risk of extinction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors) and State Rank of S4 (Apparently secure; uncommon but not rare; no immediate conservation concern).." Furthermore, the following text has been added on page 5.3-18 within the discussion of BIO Impact 1: "Bats potentially use the project area for foraging but are not known to roost in the project area and current proposed construction activities would have little to no direct impact on bat species. Potential indirect impacts to existing bat populations may be sustained from changes to the

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	existing habitat including those related to the removal of vegetation and changes to lighting. However, no significant change in the amount of lighting from within buildings is proposed. The new museum building would close at 5 pm, as the Page Museum closes now. Thus, no change in the timing of building illuminations would occur. In addition, only warm-white toned LEDs would be incorporated into lighting regimes during the nighttime (between dawn and dusk). Light shields that limit the light flux only to required areas and thereby avoiding as much light trespass into potential transitory pathways of the bats may be used. Lighting in areas of highest sensitivity where bats are most likely to occur (i.e., any ponding or surface water and areas of dense canopy) would be limited. For these reasons, impacts created by the proposed project would not result in a demonstrable change from existing conditions and would not be significant." As demonstrated above, lighting impacts created by the proposed project would not result in a substantial change from existing conditions. Therefore, related impacts to bat species would be less than significant. It should be noted that no "significant new information" has been identified as a result of these changes. According to State CEQA Guidelines 15088.5: Recirculation is not required where the new information added to the EIR merely clarifies or amplifies or makes insignificant modifications in an adequate EIR. These revisions do not affect any conclusions or significance determinations provided in the Draft EIR. Instead, the revisions only clarify and support the discussion regarding impacts to sensitive species included in the Draft EIR. As no significant modifications have been made, recirculation of the EIR is not required.
LAA-17	The commenter asks how construction will affect the bat species. Specifically, how will lighting from the project affect bat species. The commenter further indicates that bats are known to be sensitive to lighting impacts and that the EIR does not identify the presence of bat species, including one sensitive species. The commenter asks that the impacts of construction of the project, including tree removal and installation of new lighting, be considered. Through on-going management and operation of the property, the County will ensure that lighting from within is reduced to the extent feasible while retaining enough lighting for security and safety needs. This commitment is made for both existing and new facilities. The new museum building is not anticipated to be lit from within to any greater degree than the existing Page Museum. Lighting from within would be limited to dim security lighting, like the existing conditions at the Page Museum. No significant change in the amount of lighting from within buildings would occur. Thus, no change in the timing of building illuminations would occur. Refer to response to comments LAA-16. Through this Final EIR process, the analysis within EIR Section 5.3, Biological Resources has been updated to include consideration for bat species (see pages 5.3-8, 5.3-9, 5.3-18, and 5.3-25). As discussed under impact questions (a) and (d), these considerations include potential indirect impacts resulting from changes to the exiting habitat, including those related to the removal of vegetation and changes to lighting. The current proposed construction activities would have little to no direct impact to bat species, as no known roosting habitat would be impacted or reduced. Further, lighting at the project site after construction would be similar to existing lighting at the site. The following text has been added on page 5.3-18 within the discussion of BIO Impact 1: "Bats potentially use the project area for foraging but are not known to roost in the project area and current proposed construction activities would have little to no direct impact on bat species. Potential indirect impacts to existing bat populations may be sustained from changes to the existing habitat including those related to the removal of vegetation and changes to lighting. However, no significant change in the amount of lighting from within buildings is proposed. The new museum building would close at 5 pm, as the Page Museum closes now. Thus, no change in the timing of building illuminations would occur. In addition, only warm-white toned LEDs would be incorporated into lighting regimes during the nighttime (between dawn and dusk). Light shields that limit the light flux only to required areas and thereby avoiding as much light trespass into potential transitory pathways of the bats may be used. Lighting in areas of highest sensitivity where bats are most likely to occur (i.e., any ponding or surface water and areas of dense canopy) would be limited. For these reasons, impacts created by the proposed project would not result in a demonstrable change from existing conditions and would not be significant." Therefore, lighting impacts created by the proposed project would not result in a substantial change from existing conditions, and related impacts to bat species would be less than significant. It should be noted that no "significant new information" has been identified as a result of these changes. According to State CEQA Guidelines 15088.5: Recirculation is not required where the new information added to the EIR merely clarifies or amplifies or makes insignificant modifications in an adequate EIR. These revisions do not affect any conclusions or significance determinations provided in the Draft EIR. Instead, the revisions only clarify and support the discussion regarding impacts to sensitive species included in the Draft EIR. As no significant modifications have been made, recirculation of the EIR is not required.
LAA-18	The commenter indicates that Audubon is available to work with the County to further develop the project. The County appreciates the input that Audubon has provided on the project to-date, and it is being considered throughout the design process. The Foundation and the County welcome the opportunity to work with Audubon as the design progresses.

2.3.3 Los Angeles Conservancy

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October 26, 2023

Submitted Electronically

Leslie Negritto, Chief Operating Officer
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900 Exposition Boulevard
Los Angeles, California 90007

RE: Draft Environmental Impact Report for the La Brea Tar Pits Master Plan Project

Dear Ms. Negritto:

On behalf of the Los Angeles Conservancy, I am writing to comment on the Draft Environmental Impact Report (EIR) for the La Brea Tar Pits Master Plan Project. As we previously stated in our Notice of Preparation (NOP) comments, the La Brea Tar Pits and the George C. Page Museum (Page Museum) are significant and identified historic resources operated by the Natural History Museums of Los Angeles County (NHMLAC), located on portions of the 23-acre Hancock Park. We have been encouraged by early design concepts, and thank NHMLAC staff for their ongoing collaboration and meetings with the Conservancy on this project and undertaking. LAC-1

Based on the impacts analysis provided within the DEIR, and the severity of the potential loss of historic resources, we are concerned. The Conservancy would like to work with the NHMLAC staff and team further to consider alternatives. We strongly believe it is possible to achieve a "win-win" outcome, meeting both project objectives and goals through either a reduction or elimination of the current significant impacts to historic resources as a result of this project. LAC-2

I. Proposed renovation of the existing Page Museum, new two-story museum building, and modifications to the existing site plan and identified historic district

The project site includes 13 acres of the eastern and northwestern portions of Hancock Park and broadly encompasses what is known as La Brea Tar Pits, which includes the George C. Page Museum (Page Museum). Hancock Park and the La Brea Tar Pits were first deemed eligible for listing in the National Register of Historic Places in 1984. More recently, in 2014, the La Brea Tar Pits, Hancock Park, and the Page Museum were all identified as eligible for LAC-3 designation at the local, state, and national levels through the City of Los Angeles's SurveyLA historic resources survey.

While a number of historic resources are identified and analyzed as part of this DEIR, the two primary resources consist of the 1) La Brea Tar Pits Historic District and 2) George C. Page Museum. The La Brea Tar Pits Historic District is eligible for landmark designation at the state, county, and city levels, and previous analysis also determined its eligibility for the National Register of Historic Places. The historic district consists of related cultural/paleontological resources, site/landscape features, and institutional facilities reflecting the story of over 100 years of scientific excavation, study, public education, and exhibition of one of the world's most significant concentrations of Pleistocene-age fossils.

The 1977 Page Museum was identified as eligible for landmark designation at the state, county, and city levels, in addition to the National Register of Historic Places. The building was documented as an "excellent example of Late Modern institutional architecture, designed by local architecture firm Thornton and Fagan."

As defined in the DEIR, the project would:

> "...renovate the existing Page Museum within the same footprint as the existing building (currently approximately 63,200 square feet) to allow for an enlarged exhibition space, additional collections storage, a ground floor café, and retail space. The central atrium would be renovated to provide additional exhibitions, an additional classroom, and visible laboratory space. A sloped green roof would be installed north of the Page Museum and would curve to the west. The project would add several sustainability features to the Page Museum. The features include enhanced daylighting, rainwater collection leading to bioswales, a sloped green roof, and rooftop solar photovoltaic panels."

LAC-3 (cont'd)

Further, the project envisions a new, two-story museum building to be built northwest of the Page Museum. At approximately 40,000 square feet in size, this would increase the total museum square footage to 104,000 gross square feet.

The project would renovate the existing facilities at all the tar pits in the western portion of the project site. Also planned is a renovation of the existing entrance to La Brea Tar Pits located at Wilshire Boulevard and South Curson Avenue. A large, shaded canopy would stretch down Wilshire Boulevard and curve around to South Curson Avenue to create a new welcome pavilion and shaded entry plaza – the Wilshire Gateway. This gateway would provide orientation, spaces for gathering and queuing, and restrooms. A picnic area would also be located under the shaded canopy. A pedestrian bridge and walking path would be constructed over the Lake Pit. Directly to the east of the Lake Pit, a new garden bioswale would be installed to manage stormwater and would include vegetation related to the relocated mammoths and mastodon sculptures.

II. The Master Plan should avoid and minimize, to the greatest extent possible, significant adverse impacts to the La Brea Tar Pits Historic District and George C. Page Museum **LAC-4**

The project introduces a series of new features, buildings, structures, circulation corridors, and other elements that would fill-in and divide the components of the La Brea Tar Pits Historic District, shifting **LAC-5** the setting and feeling of the historic district and removing some of its character defining features. Based on previous conversations and discussions with the NHMLAC staff team, the Conservancy anticipated some of these potential impacts to the overall historic district. The DEIR analysis states:

> "Implementation of the project would result in a comprehensive redesign of Hancock Park, which would erode and interrupt the eclectic but cohesive character-defining features of this historic district such that it would no longer convey the reasons for its significance as a CRHR- and locally eligible historic district."

Much of our conversation to date has been focused on the Page Museum, an individually-eligible historic resource and focal point of the historic district. The proposed scope of the remodel and modifications, including necessary seismic and systems upgrades, will also result in a significant impact to the Page Museum. Specifically, the project and its scope will adversely impact the following character defining features of the Page Museum:

- Elimination of the sharply raised berms on the west and north elevations of the museum site
- Eliminating the indoor-outdoor integration provided by the open roof, podium, and central atrium, by adding a roof structure and photovoltaic panels and enclosing the open space at the podium with fenestration
- Adding windows beneath the Pleistocene-era frieze, which will diminish the museum's high degree of indoor-outdoor integration and the visual prominence of the frieze as one of the key character-defining features of the museum
- Shifting the principal entrance to the new museum building; the principal, descending entrance ramp to the Page Museum would be retained physically but converted in use to serve as an outdoor classroom space; the main entrance to the museum would shift to the annex to the west
- Demolition of a portion of the museum's northwest corner
- A site redesign in which the Page Museum, which is presently a prominent, stand-alone feature, would be incorporated as one component of an integrated, connected three-part complex, including built-up berms on the west and north, a public promenade, and new museum building; new construction does not include visual, physical distinctions and separations between the old and the new
- Construction of the new museum building, which, though on par with or slightly higher than the Page Museum, would visually compete with the Page Museum

LAC-5 (cont'd)

Based on the totality of the significant impacts proposed as part of this project to both the La Brea Tar Pits Historic District and the Page Museum, the Conservancy is concerned. Full build out of the La Brea Tar Pits Master Plan Project, as currently proposed, would result in both historic resources losing their eligibility, and an overall loss to the broad architectural and cultural heritage of Los Angeles County.

LAC-6

III. Draft EIR Project Alternatives should be fully analyzed and considered, expanded in scope where necessary, and selected to reduce significant impacts to the existing historic resources

The Master Plan must fully incorporate historic preservation into its goals and objectives to ensure the project meets the Secretary of the Interior's Standards for Rehabilitation. Compliance with the Standards allows all historic resources on the site to remain eligible for designation at the local, state, and national levels. A range of preservation alternatives, including those contained with this DEIR, and others that still might be considered, can help meet this goal. **LAC-7**

Three project alternatives are included in the DEIR. This includes:

Alternative 1: Renovate Page Museum Only
Alternative 2: Maintain Central Atrium Pleistocene Garden.
Alternative 3: Adjust Footprint to Reduce Contact with Page Museum and Expand Central Green **LAC-8**

Alternatives 1 and 3 reduce significant impacts, but only Alternative 1 achieves a preservation-based approach that results in less than significant impacts to the La Brea Tar Pits Historic District and the Page Museum. While it would not meet most of the project objectives, Alternative 1 is the alternative scenario that reduces the most environmental impacts when compared to the project. Alternative 3 would lessen certain impacts to character-defining features to both the Page Museum and the La Brea Tar Pits Historic District, thereby reducing the overall severity of the impacts to historical resources. Alternative 3 is the alternative that meets all project objectives by providing an adjusted museum footprint and incorporating a series of design refinements that would support the basic objectives of the project. **LAC-9**

A key policy under the CEQA is the lead agency's duty to "take all action necessary to provide the people of this state with historic environmental qualities and preserve for future generations examples of major periods of California history."[1] To this end, CEQA "requires public agencies to deny approval of a project with significant adverse effects when feasible alternatives or feasible mitigation measures can substantially lessen such effects."[2] **LAC-10**

While additional mitigation measures can help, we do not believe they can outweigh the environmental impacts that cannot currently be avoided or mitigated to a less than significant level. Therefore, the Conservancy strongly recommends consideration of either Alternatives 1 or 3, or an expanded and modified version of either, to attempt to better meet project objectives and avoid and reduce significant impacts to historic resources. The Conservancy believes this needs to be resolved and further studied before proceeding with a Final Environmental Impact Report. **LAC-11**

I. The Conservancy requests additional meetings with the La Brea Tar Pits Master Plan Team

The Conservancy requests and welcomes the opportunity to further meet with NHMLAC staff and team, to work collaboratively toward a "win-win" outcome. Our desire is to help NHMLAC staff meet intended project objectives while also finding a way and a project scope that reduces significant impacts to **LAC-12**

[1] Public Resource Code, Sec. 21001 (b), (c).
[2] *Sierra Club v. Gilroy City Council* (1990) 222 Cal.App.3d 30, 41; also see Public Resources Code §§ 21002, 21002.1.

historic resources, including maintaining the current historic eligibility status for both the La Brea Tar Pits Historic District and George C. Page Museum. Both of these historic places are too important to risk losing. Therefore, we're committed to working with you to find and develop an acceptable preservation-based outcome. We have been successful in doing this elsewhere and finding common ground, and believe that is possible in this case as well. **LAC-12 (cont'd)**

About the Los Angeles Conservancy:
The Los Angeles Conservancy is the largest local historic preservation organization in the United States, with nearly 5,000 members throughout the Los Angeles area. Established in 1978, the Conservancy works to preserve and revitalize the significant architectural and cultural heritage of Los Angeles County through advocacy and education. **LAC-13**

Please do not hesitate to contact me at (213) 430-4203 or afine@laconservancy.org should you have any questions or concerns.

Sincerely,

Adrian Scott Fine

Adrian Scott Fine
Senior Director of Advocacy

2.3.3.1 Response to Letter from Los Angeles Conservancy

Comment No.	Response
LAC-1	The comment introduces the letter, provides an overview of the Los Angeles Conservancy (Conservancy), and notes the prior comments made on the scope of the EIR in response to the Notice of Preparation. The comment further notes that the Conservancy has been encouraged by the early design concepts for the project and that the organization looks forward to ongoing collaborations with the County. The County would like to thank the commenter for participating in the public review process of the Draft EIR. A copy of this comment letter will be included in the Final EIR, which will be provided to the Board of Supervisors for review when the project is considered for approval. It is important to note that this letter does not state any concern or critique of the analysis contained within the Draft EIR. However, the County is providing responses to the project concerns raised to provide as much information and transparency to the commenter and interested parties as possible. The County appreciate the Conservancy's participation in the process. The comment is introductory in nature and provides information regarding the previous involvement of the organization in collaboration and meetings with the Conservancy on the project.
LAC-2	The commenter notes that because of the severity of the potential loss of historic resources, as reflected in the analysis contained in the Draft EIR, that the Conservancy would like to work further with the County to consider alternatives. After receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including the Conservancy, and refined the design of the improvements proposed at the La Brea Tar Pits site, including exploring changes to the project design to reduce the historic impacts identified by Section 5.5, Cultural Resources – Historical Resources. The County will be recommending approval of Refined Alternative 3 by the Board of Supervisors. This variation of the Master Plan is a refined version of the original Alternative 3 and is presented in Chapter 6, Alternatives Analysis, of the EIR. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information provided by the updated designs, Refined Alternative 3 and the County's commitment to reducing historical impacts to the degree possible while still meeting the objectives of the project. After developing concept drawings for Refined Alternative 3, the County met with the President and Chief Executive Officer of the Los Angeles Conservancy on January 30, 2024, to review the new concepts. County representatives reviewed the elements of Refined Alternative 3 and answered questions on the changes that were made to address the Conservancy's comments. After the January meeting, the Conservancy shared, via email to Leslie Negritto, Chief Financial and Operating Officer of the Foundation, that the Board of Directors of the Conservancy was pleased to hear of the changes that were made through Refined Alternative 3, and that the Board is appreciative of the direction that's now being pursued (March 6, 2024). This comment is consistent with the information provided in the EIR and does not raise a specific issue pertaining to the analysis provided in the EIR; for this reason, no additional response is provided, and no changes to the EIR were determined to be necessary in response to this comment.
LAC-3	The commenter provides a narrative of the Conservancy's understanding of the project site and its importance as a historical resource. The comment summarizes content provided in the EIR, including information included in EIR Section 5.5, Cultural Resources – Historic Resources. This comment is consistent with the EIR and does not raise a specific issue pertaining to the analysis provided in the EIR; for this reason, no additional response is provided, and no changes to the EIR were determined to be necessary in response to this comment.
LAC-4	This comment summarizes the commenter's concern regarding significant adverse impacts to the La Brea Tar Pits Historic District and Page Museum. This comment is consistent with the information provided in the EIR and does not raise a specific issue pertaining to the analysis provided in the EIR; for this reason, no additional response is provided, and no changes to the EIR were determined to be necessary in response to this comment.
LAC-5	This comment summarizes content provided in the EIR in Section 5.5, Cultural Resources – Historical Resources (pages 5.5-23, 5.5-24, and 5.5-27) and indicates that the Conservancy anticipated that some potential historical resource impacts would be identified for the project. This comment is consistent with the information provided in the EIR and does not raise a specific issue pertaining to the analysis provided in the EIR; for this reason, no additional response is provided, and no changes to the EIR were determined to be necessary in response to this comment.
LAC-6	This comment indicates that the Conservancy is concerned that the full scope of impacts identified in Section 5.5, Cultural Resources – Historical Resources, could occur. The commenter notes that full build out of the La Brea Tar Pits Master Plan project, as reflected in the EIR (specifically Chapter 3, Project Description) would result in both historic resources losing their eligibility, and an overall loss to the broad architectural and cultural heritage of Los Angeles County. As noted in response to comment LAC-2, after receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including the Conservancy, and refined the design of the improvements proposed at the La Brea Tar Pits site, including exploring changes to the project design to reduce the historic impacts identified by Section 5.5, Cultural Resources – Historical Resources. As a result, the County has developed a variation of the proposed Master Plan which is described in the Final EIR. Refer to **MR-1, Preferred Alternative,** for more information.

Comment No.	Response
	It is important to note that, after developing concept drawings for Refined Alternative 3, the County met with the President and Chief Executive Officer of the Los Angeles Conservancy on January 30, 2024, to review the new concepts. County representatives reviewed the elements of Refined Alternative 3 and answered questions on the changes that were made to address the Conservancy's comments. After the meeting the Conservancy shared, via email to Leslie Negritto, Chief Financial and Operating Officer of the Foundation, that the Board of Directors of the Conservancy was pleased to hear of the changes that were made through Refined Alternative 3, and that the Board is appreciative of the direction that's now being pursued (March 6, 2024).
LAC-7	The commenter indicates that alternatives should be fully analyzed and considered, including an expansion in scope where necessary. The commenter further opines that the project must fully incorporate historic preservation into its goals and objectives to ensure the project meets the Secretary of the Interior's Standards for Rehabilitation. The Conservancy states that a range of preservation alternatives could help meet the goals of retaining historic preservation goals. As noted in response to comment LAC-2, County representatives reviewed the elements of Refined Alternative 3 at a meeting with the Conservancy on January 30, 2024. After the meeting, on March 6, 2024, the Conservancy shared, via email to Leslie Negritto, Chief Financial and Operating Officer of the Foundation, that the Board of Directors of the Conservancy was pleased to hear of the changes that were made through Refined Alternative 3, and that the Board is appreciative of the direction that's now being pursued. Additionally, the County, the design team, and the EIR consultant's historic resource specialists continued to work together to refine the project designs considering the potential for impact to historical resources. As a result, the County has included a variation of the Master Plan for consideration by the Board of Supervisors. Refer to **MR-1, Preferred Alternative,** for more information. Regarding the comment that the incorporation of additional alternatives into the EIR could help meet the preservation goals of the project, the EIR considers a range of reasonable alternatives that would meet most of the basic project objectives, are considered to be potentially feasible, and would avoid or substantially reduce one or more of the potentially significant impacts of the project. Additionally, the information regarding Refined Alternative 3 has also been further expanded through the Final EIR in order to provide additional feasibility information into the analysis. As the County developed this version of the project after the close of the Draft EIR comment period, it became evident that implementation of this alternative would be less impactful when compared with the project described as the original Master Plan. While the broader vision of the Master Plan remains intact, the County and the design team have been able to incorporate the findings of the historical resources analysis and the comments of the Conservancy into a more environmentally superior option, which protects the historical values and importance of the sites resources to the extent feasible while still meeting the objectives of the project. In this context, it should be noted that, under CEQA, an EIR is not required to consider every conceivable alternative to the project; rather an EIR need only consider a reasonable range of alternatives. The EIR describes the alternatives that were considered but rejected, the reasons they were not carried forward for analysis, and the four alternatives that were carried forward for analysis. These suggested alternatives either were considered and rejected, included in the EIR's evaluation of alternatives, or discussed as to why they are not feasible alternatives. CEQA does not require further consideration of any additional alternatives suggested by the comments. However, the County have expanded the consideration of Refined Alternative 3 within the analysis provided by Chapter 6, Alternatives Analysis. The County was unable to develop an alternative consistent with the objectives of the project which completely preserved the historic integrity of the site. As detailed in EIR Section 6.2, many of the project objectives necessitate the expansion of existing museum facilities, or the construction of new facilities. These objectives would be impossible to achieve while also completely maintaining the existing conditions of the site. Many of the existing facilities which would need to be updated, such as the pedestrian entrances, the Page Museum, and the pit viewing areas, are considered important to the historic qualities of the site. Instead, Refined Alternative 3 was selected to strike a balance between preserving the historic elements of the site, and achieving the project objectives.
LAC-8	This comment summarizes content provided in the EIR in Chapter 2, Section 2.8, Project Alternatives (pages 2-59 and 2-60). This comment is consistent with the information provided in the EIR and does not raise a specific issue pertaining to the analysis provided in the EIR; for this reason, no additional response is necessary, and no changes to the EIR were determined to be necessary in response to this comment.
LAC-9	This comment reflects the Conservancy's understanding that, of the alternatives presented in the EIR, Alternatives 1 and 3 reduce significant historical resource impacts, which is consistent with the analysis contained in the EIR. The Conservancy further reflects that Alternative 1 achieves a preservation-based approach that results in less than significant impacts to the La Brea Tar Pits Historic District and the Page Museum, and that Refined Alternative 3 is the alternative that meets all project objectives by providing an adjusted museum footprint and incorporating a series of design refinements that would support the basic objectives of the project. The County agrees with this comment. However, as described in the EIR, Chapter 6, Alternatives Analysis (page 6-19), Alternative 1, Renovate Page Museum Only, would not meet most of the project objectives. Specifically, it would only fully meet one of the project objectives, partially achieve another two of the objectives, and not meet the remaining objectives. Table 6-5 of the EIR, in Chapter 6 Alternatives Analysis, provides detail on this assessment. Importantly, Alternative 1 would <u>not</u> meet the following objectives of the La Brea Tar Pits Master Plan:

Comment No.	Response
	• Provide expanded collections storage facilities that enable access for scientific research, and preserve, protect, and allow future growth of the museum's world-class collections. • Provide expanded state-of-the-art laboratory research facilities to accommodate internationally significant and advanced research in paleontology. • Improve access and entry for different visitor types, increase connections between the museum and the park, as well as support increased visitation, special events, and revenue-producing amenities within the park and museum. • Expand the museum exhibits, educational classrooms, collection spaces, offices, and laboratory research facilities in one unified, cohesive facility, with the fewest impacts to historical resources possible. • Create a central entrance to the museum facilities to enhance the visitor experience of the museum and Hancock Park. • Redesign and renovate the Hancock Park community park green space as an expression of the goals of the City of Los Angeles's General Plan Conservation and Natural Resources Element and the City of Los Angeles's Open Space and Conservation Elements of the General Plan, to increase sustainable landscape and site design, to support passive recreational use, to increase the legibility of this important cultural destination, and to enhance connections to the quickly evolving Miracle Mile neighborhood. Because Alternative 1 does not achieve most of the project's objectives, the County have not explored this option further. However, significant exploration of the feasibility and viability of the original Alternative 3 has occurred since the close of the Draft EIR public comment period. Through this exploration, refinements to the original Alternative 3 have been developed, which are presented in Chapter 6, Alternatives Analysis, of this EIR. As a result, the County will be recommending approval of Refined Alternative 3 by the Board of Supervisors. The Refined Alternative 3 is presented in Figures 6-4, 6-5, and 6-6 of this Final EIR. Refined Alternative 3 does not create additional environmental impacts when compared to the original Alternative 3 concept, as further detailed in the environmental evaluation contained in Chapter 6, Alternatives Analysis. Below are some key variations in Refined Alternative 3 that are considered in the Final EIR alternatives analysis: • The central, open atrium of the Page Museum, which contributes to the indoor-outdoor integration of the museum and is a primary character-defining feature, would no longer be covered and converted to indoor space; it would remain as an open atrium garden. It would continue to include landscaping; the landscaping and hardscaping features of the atrium would be renovated to create a more useable public space with vegetation relevant to interpretive themes of the tar pits. This differs from the original Alternative 3, which replaced the open atrium garden with research laboratory space. • The structural space frame that supports the frieze (including the open-air, steel-grid roof that enhances the indoor-outdoor integration of the Page Museum and is a primary character-defining feature) would not be altered or capped, as had been proposed in the original Alternative 3; the existing space frame and open-air grid roof would remain intact as is. • The Page Museum and the new museum building would be connected only with a covered, open-air breezeway; the original Alternative 3 proposed a physical connection/joining of the two buildings. An entrance would be incorporated into the northwestern corner of the Page Museum to provide access to the breezeway. • Because the connection point for the existing Page Museum and the new museum building would be decreased, demolition of the northwest corner of the Page Museum would be avoided, thereby retaining more of the original character-defining features and materials of the historical resource. However, the removal of the berm surrounding the west wall of the Page Museum would still be necessary as proposed in the original Alternative 3. Refer to **MR-1, Preferred Alternative,** for more information.
LAC-10	The Conservancy provides reference to directives of CEQA and references published case law in support of the commenter's position. This comment references Public Resources Code (PRC) sections and implies that a lead agency is obligated to deny a project that has the potential to result in significant adverse effects on the environment (specifically, the historic environment). The Conservancy partially references PRC § 21001 (b) and (c), PRC §§ 21002, 21002.1, and case law *Sierra Club v. Gilroy City Council* (1990). Referenced PRC sections (in full) are provided below. PRC § 21001: (b) Take all action necessary to provide the people of this state with clean air and water, enjoyment of aesthetic, natural, scenic, and historic environmental qualities, and freedom from excessive noise. (c) Prevent the elimination of fish or wildlife species due to man's activities, insure that fish and wildlife populations do not drop below self-perpetuating levels, and preserve for future generations representations of all plant and animal communities and examples of the major periods of California history. Additionally, it is worth noting that PRC§ 21001 also includes the following sections which address a duty to take action to rehabilitate and enhance environmental qualities and consider economic and long-range benefits while making determinations regarding proposed projects: (a) Develop and maintain a high-quality environment now and in the future, and take all action necessary to protect, rehabilitate, and enhance the environmental quality of the state. (g) Require governmental agencies at all levels to consider qualitative factors as well as economic and technical factors and long-term benefits and costs, in addition to short-term benefits and costs and to consider alternatives to proposed actions affecting the environment.

Comment No.	Response
	PRC § 21002: The Legislature finds and declares that it is the policy of the state that public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects, and that the procedures required by this division are intended to assist public agencies in systematically identifying both the significant effects of proposed projects and the feasible alternatives or feasible mitigation measures which will avoid or substantially lessen such significant effects. The Legislature further finds and declares that in the event specific economic, social, or other conditions make infeasible such project alternatives or such mitigation measures, individual projects may be approved in spite of one or more significant effects thereof. PRC § 21002.1: In order to achieve the objectives set forth in Section 21002, the Legislature hereby finds and declares that the following policy shall apply to the use of environmental impact reports prepared pursuant to this division: (a) The purpose of an environmental impact report is to identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided. (b) Each public agency shall mitigate or avoid the significant effects on the environment of projects that it carries out or approves whenever it is feasible to do so. (c) If economic, social, or other conditions make it infeasible to mitigate one or more significant effects on the environment of a project, the project may nonetheless be carried out or approved at the discretion of a public agency if the project is otherwise permissible under applicable laws and regulations. (d) In applying the policies of subdivisions (b) and (c) to individual projects, the responsibility of the lead agency shall differ from that of a responsible agency. The lead agency shall be responsible for considering the effects, both individual and collective, of all activities involved in a project. A responsible agency shall be responsible for considering only the effects of those activities involved in a project which it is required by law to carry out or approve. This subdivision applies only to decisions by a public agency to carry out or approve a project and does not otherwise affect the scope of the comments that the public agency may wish to make pursuant to Section 21104 or 21153. (e) To provide more meaningful public disclosure, reduce the time and cost required to prepare an environmental impact report, and focus on potentially significant effects on the environment of a proposed project, lead agencies shall, in accordance with Section 21100, focus the discussion in the environmental impact report on those potential effects on the environment of a proposed project which the lead agency has determined are or may be significant. Lead agencies may limit discussion on other effects to a brief explanation as to why those effects are not potentially significant. Regarding the *Sierra Club v. Gilroy City Council* (1990) case referenced by the Conservancy, it is implied (in referencing this case law), that CEQA requires public agencies to deny approval of a project with significant adverse effect when feasible alternatives or feasible mitigation measures can substantially lessen such effects. The *Sierra Club v. Gilroy City Council* case involved the loss of viable habitat for the California tiger salamander and the specifics of the case are not necessarily equivalent to the loss of eligibility of a historic resource due to rehabilitation of the resource. However, the PRC and the State CEQA Guidelines indicate that, when economic, social, or other conditions make project alternatives infeasible, projects may be approved despite one or more significant effects. Specifically, as noted above through PRC § 21002.1 (b) and (c), public agencies are only required to mitigate or avoid significant effects when it is feasible to do so and if economic, social, or other conditions make it infeasible to mitigate one or more significant effects on the environment of a project, the project may nonetheless be carried out or approved at the discretion of a public agency. The exploration of feasible alternatives that attain some or most of the project's objectives but reduce environmental impacts is provided in Chapter 6, Alternative Analysis, of the EIR. Refined Alternative 3, Adjust Footprint to Reduce Contact with Page Museum and Expand Central Green, would result in similar environmental impacts as the project for each issue area analyzed in this EIR, except for historical resources. Refined Alternative 3 would lessen certain impacts to character-defining features to both the Page Museum and the La Brea Tar Pits Historic District thereby reducing the overall severity of the impacts to historical resources; however, it would not avoid the project’s significant and unavoidable impacts. Similarly, the design refinements in this alternative would help to further support the land uses plans and policies applicable to the project as they relate to the protection and alternation of historical resources, but not in such a way to avoid the project’s related significant and unavoidable impacts. Refined Alternative 3 is the alternative that meets all project objectives by providing an adjusted museum footprint and incorporating a series of design refinements that would support the basic objectives of the project and reduces impacts to historic resources, although not to a level below significance. No changes to the EIR were determined to be necessary in response to this comment.
LAC-11	The commenter indicates that mitigation measures can help, but do not outweigh the concerns regarding the design of the Master Plan. It is important to note that, when making this comment, the Conservancy is considering the project designs as portrayed in Chapter 3, Project Description, of the Draft EIR. The commenter goes on to comment that they “strongly recommend” that either Alternative 1 or 3 (or an expanded and modified version of either) be considered to “better meet project objectives and avoid and reduce significant impacts to historic resources.” Furthermore, the commenter “believes this needs to be resolved and further studied before proceeding with a Final EIR.” The County, the design team, and the EIR consultant’s historic resource specialists continued to work together to refine the project designs considering the potential for impact to historical resources. Because Alternative 1 does not achieve most of the project’s objectives, the County has not explored this option further. However,

Comment No.	Response
	significant exploration of the feasibility and viability of the original Alternative 3 has occurred since the close of the Draft EIR public comment period as discussed with the Conservancy on January 30, 2024. In this Final EIR, consideration of the original Alternative 3 has been expanded and the design refined to preserve more character-defining features of the Page Museum. As a result, the County will be pursuing Refined Alternative 3 for approval by the Board of Supervisors. Refined Alternative 3 and the expanded analysis is provided in Chapter 6, Alternatives Analysis, of this Final EIR. Specifically, Figures 6-4, 6-5, and 6-6 provide the further development and refinement of the concept designs for Refined Alternative 3. Below are some key variations in Refined Alternative 3 that are considered in the Final EIR alternatives analysis: • The central, open atrium of the Page Museum, which contributes to the indoor-outdoor integration of the museum and is a primary character-defining feature, would no longer be covered and converted to indoor space; it would remain as an open atrium garden. It would continue to include landscaping; the landscaping and hardscaping features of the atrium would be renovated to create a more useable public space with vegetation relevant to interpretive themes of the tar pits. This differs from the original Alternative 3, which replaced the open atrium garden with research laboratory space. • The structural space frame that supports the frieze (including the open-air, steel-grid roof that enhances the indoor-outdoor integration of the Page Museum and is a primary character-defining feature) would not be altered or capped, as had been proposed in the original Alternative 3; the existing space frame and open-air grid roof would remain intact as is. • The Page Museum and the new museum building would be connected only with a covered, open-air breezeway; the original Alternative 3 proposed a physical connection/joining of the two buildings. An entrance would be incorporated into the northwestern corner of the Page Museum to provide access to the breezeway. • Because the connection point for the existing Page Museum and the new museum building would be decreased, demolition of the northwest corner of the Page Museum would be avoided, thereby retaining more of the original character-defining features and materials of the historical resource. However, the removal of the berm surrounding the west wall of the Page Museum would still be necessary as proposed in the original Alternative 3. Refined Alternative 3 does not create additional environmental impacts when compared to the original Alternative 3 concept, as further detailed in each of the environmental evaluations contained in Chapter 6, Alternatives Analysis. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information provided by Refined Alternative 3 and the refined designs.
LAC-12	The Conservancy requests that additional meetings with La Brea Tar Pits Master Plan team occur to work collaboratively on the design of the project. The Conservancy further notes that their desire is to help to meet the intended project objectives while also finding a way to reduce significant historic impacts. As noted in response to comment LAC-2, County representatives reviewed the elements of Refined Alternative 3 at a meeting with the Conservancy on January 30, 2024. After the meeting, on March 6, 2024, the Conservancy shared, via email to Leslie Negritto, Chief Financial and Operating Officer of the Foundation, that the Board of Directors of the Conservancy was pleased to hear of the changes that were made through Refined Alternative 3, and that the Board is appreciative of the direction that's now being pursued. Please also refer to response to comment LAC-11. The County, the design team, and the EIR consultant's historic resource specialists continued to work together to refine the project designs considering the potential for impact to historical resources. As a result, the County has included a variation of the Master Plan for consideration l by the Board of Supervisors, which is consistent with Refined Alternative 3. This variation of the Master Plan is addressed in Chapter 6, Alternatives Analysis, of this Final EIR. Refer to **MR-1, Preferred Alternative,** for more information regarding the additional information regarding the County's preferred alternative.
LAC-13	In closing the letter, the Conservancy summarizes that the Los Angeles Conservancy is the largest local historic preservation organization in the United States, with nearly 5,000 members throughout the Los Angeles area, that the Conservancy was established in 1978, and that the organization works to preserve and revitalize the significant architectural and cultural heritage of Los Angeles County through advocacy and education. This comment does not provide additional input into the project design or the EIR process; therefore, no response is required. The County appreciates the Conservancy's attention to this important project, as represented through the various communications received on the project as well as the meetings with the County that the Conservancy has participated in. No changes to the EIR were determined to be necessary in response to this comment

2.3.4 Neighborhood Council Sustainability Alliance of Los Angeles

NEIGHBORHOOD COUNCIL
SUSTAINABILITY
ALLIANCE

October 26, 2023

Re: La Brea Tar Pits Master Plan

Please see the attached letter, which our representatives voted to support.

Thank you,

Lisa Hart

Lisa Hart
Executive Director

NEIGHBORHOOD COUNCIL
SUSTAINABILITY
ALLIANCE

October 26, 2023

Leslie Negritto, Chief Operating Officer
Natural History Museums of Los Angeles County
900 Exposition Boulevard
Los Angeles, California 90007
Via e-mail: Leslie Negritto, reimagine@tarpits.org

RE: Public Comment On Proposed La Brea Tar Pits Master Plan Project

Dear Chief Operating Officer Negritto:

The Neighborhood Council Sustainability Alliance (NCSA) has important concerns with the environmental impact of the Master Plan Project as presented by the Natural History Museums of Los Angeles County (NHM) to expand the Page Museum and facilities at the La Brea Tar Pits. **NCSA-1** Over the course of the past two years, objections have been voiced to project representatives regarding mature tree loss—especially native tree and other native plant removals that are crucial to the ecosystem. Many individual objections came from members of the NCSA Trees Committee who are versed in the value of these assets. Yet these concerns have had no discernible influence on the project. **NCSA-2**

We question why this DEIR is offered without a tree inventory, and why it provides no specific disclosure of which trees would be removed and which retained? These are standard elements of a CEQA document, and their absence leads us to challenge how this EIR can be accepted without this disclosure. **NCSA-3**

A representative of the NCSA Trees Committee who attended your September 30 outreach event and walked the site had positive engagement with several Gruen Associates including architect Debra Gerod and also members of the landscape design team including Ronnick Licudo and Nicholas Decker. The latter two representatives were joined by another associate, Dean Howell, at our NCSA Advocacy meeting of October 1. **NCSA-4**

Below we take issue with the environmental evaluation of the Master Plan Project as presented. Text from the DEIR is cited. A numbered list of minimum expectations for the project is presented later in this comment letter.

From the DEIR Appendix B p. 29:

Existing trees and plantings throughout the park are scattered and achieve little sense of character or unity. The enhanced character of the park will require new plantings as well as existing trees and plantings that complement the concept design. Species such as the Western Sycamore, California Buckeye, and Redwood should be preserved. **NCSA-5**

With the current heat crisis in Los Angeles, we need to retain every shade-producing tree. Replacement planting deprives the City of ecosystem services for 20 years while trees attain maturity. **NCSA-6** Dr. Beverly Law, Emeritus Professor of Global Change Biology, explains how new trees initially add carbon to the atmosphere and only mature trees sequester carbon, one of the chief environmental benefits from trees.† **NCSA-7**

Given the benefits of mature trees, the "c***haracter and unity,"*** stated in the above quote from the DEIR, should not be the deciding factor for tree elimination. While the palms and agaves at the project site may be expendable, there are numerous shade trees that should be preserved but will not be in this Master Plan. **NCSA-8** Even more disturbing, the DEIR says, "Western Sycamore, California Buckeye, and Redwood should be preserved" BUT ACCORDING TO THE PRESENTATION ON SEPTEMBER 30, THESE VALUABLE NATIVE TREES ARE NOT BEING PRESERVED, AND THIS IS NOT REVEALED IN THE **NCSA-9**

DEIR. If the DEIR says native trees "should be preserved," then it should begin with an inventory of all these native trees / shrubs and demonstrate how the project will design around them. It is ironic that a project that is dedicated to educating the public about extinction does not begin with a mandate to preserve valuable specimens of extant but rare native trees and other native plants. Select highly precious native tree specimens on the Tar Pits site are cited in section 2) of this comment letter below.

NCSA-9 (cont'd)

NCSA-10

From the DEIR Appendix B p.19:

A picnic area under the canopy and shade trees provides new programming opportunities, from outdoor education and school lunches to orientation and gathering.

Again, new trees provide no appreciable shade for 20 years. At the picnic area there is an opportunity for tree preservation if the construction company is mandated to protect existing valuable trees. These trees border construction, and the builders must be sensitive to protecting existing trees instead of relying on a "planting plan." Tree preservation requires expert supervision to avoid harm to the trees.

NCSA-11

From the DEIR Appendix B p.28:

A woodland zone along the park's peripheral edges (northern, southern, eastern, and western) provides shade to the picnic areas and the parking lot to the north. These landscape zones are designed to maximize space for community, creating opportunities for the public to engage with the site's natural history and create a distinctive identity for the park to help tell La Brea's story. The planting scheme addresses the realities of Los Angeles's current and projected climate and aims to ease water consumption, ensure appropriate maintenance, promote sustainable growth, and provide a model for resilient site planning in the area.

A museum dedicated to studying past extinctions should mitigate future extinctions by committing that **EVERY new plant and tree will be native**. Experts like Doug Tallamy, PhD professor in the Department of Entomology and Ecology at the University of Delaware, author of 80 research articles and 4 bestselling books, spoke at the City of Los Angeles Community Forest Advisory Committee in the October 2023 meeting, telling us we must plant native in cities in all planting spaces. Other ecologists concur:

Native plants play a very important role in our ecosystems. As ecologists, wildlife biologists and entomologist have shown, native plant species are more favorable for supporting local wildlife, including insects such as bees and butterflies, amphibians, reptiles, and mammals. Native plants feed the creatures at the bottom of the food web that then provide meals for creatures on the next ring of the web, such as the birds.††

NCSA-12

We believe there are specific adjustments to the landscaping plan that will improve the sustainability, historical value, and cultural significance of the project. Accordingly, we request that the following changes be incorporated into the design.

NCSA-13

1) Allow biofiltration areas to recharge groundwater and irrigate lawn.

NCSA-14

As outlined in DEIR Section 3.4.7.2, the three biofiltration spaces will be lined with an impermeable liner, and water will be routed to the city stormwater drains. This is a missed opportunity. Central to the function of a true bioswale is the absorption of water for groundwater recharge. This can only be accomplished if the bioswale (or biofiltration planter) does not reside over an impermeable barrier. Therein, an unlined or partially unlined bottom in each of the three biofiltration spaces would have greater benefit to the community and the urban ecosystem by allowing some groundwater recharge. Of particular significance is that Oil Creek is a naturally occurring spring that is a fundamental component of the very system and unique phenomenon that the park celebrates. To add impermeable barriers to such a system undermines the functionality of a unique historical site, diminishing its educational value and threatening

NCSA-15

the existence of the Oil Creek spring. Importantly, it is counterintuitive to use natural systems to filter onsite water, only to dump it back into the city stormwater drain system, where it will be polluted again before reaching our local watershed. Certainly any flooding concerns could be addressed with overflow drainage in the bioswale and bioplanter designs. Groundwater flow is an inherent element of Oil Creek. **NCSA-15 (cont'd)**

The immense footprint of grass lawn in the project underscores the need to utilize onsite water sources rather than dumping naturally cleaned water into the stormwater drain. Overflow water cleaned by the biofiltration spaces should be captured as an irrigation source to offset the significant impact of using potable water to irrigate the grass lawn in the project. **NCSA-16**

2) Redesign the landscaping plan to save / incorporate four historically significant tree specimens.

The area to the northwest of the current Central Green, south of the current Pleistocene garden, contains two old-growth *Rhus ovata* (Sugarbush) and one old-growth *Heteromeles arbutifolia* (Toyon). These are visible (albeit difficult to identify) in Existing Site Figure 3-3 in the DEIR. We believe the two *Rhus ovata* are the largest specimens in the City of Los Angeles and among the largest in existence for this regionally local species. Likewise, the *Heteromeles arbutifolia*, a species declared the official native plant of Los Angeles by City Council in 2012 and a protected tree species via Los Angeles Ordinance 186873, has historical and cultural significance. A 1924 overhead photo of the site in the Los Angeles Public Library archives shows probable evidence of these three trees existing on the site a century ago. Further northwest of these three trees, north of Oil Creek and a few feet northwest of the current Pleistocene garden, is an exceptional example of *Aesculus californica* (California Buckeye) that also carries significance as being among the largest examples in the City of Los Angeles. Though the DEIR lacks a tree inventory and specifics on exactly which trees will be preserved, preliminary documents suggest all four of these trees are slated for removal. Due to their age and size, these four trees are poor candidates for survival if moved, even if the large expense and effort to do so was undertaken. However, an overlay of the Conceptual Site Plan in Figure 3-4 onto Figure 3-3 suggests these four trees are outside the proposed new building footprint and could be accommodated and preserved with minor alterations to the landscaping design. **NCSA-17**

Consider that the project site also includes two mature *Sequoia sempervirens* (Coast Redwood), two mature *Umbellularia californica* (California Bay Laurel), and several mature *Pinus torreyana* (Torrey Pine). These native trees are among the largest trees on the site, and a superior plan would have designed around them. *Umbellularia californica* is a protected species in Los Angeles and *Pinus torreyana* is an endangered species that is the rarest pine species in the United States. However, because they are within the footprint of a new building in the DEIR, we don't see how they can be saved without a major redesign of the project. The loss of these trees will constitute a significant harm to the ecosystem of the area and the cultural heritage of the region. **NCSA-18** This makes it all the more imperative that the four trees listed in the prior paragraph (which can be saved with comparatively minimal effort) be saved. **NCSA-19**

3) Removal of any native tree protected by Los Angeles Ordinance 186873 should result in the full 4:1 replacement ratio planted on site within the project boundaries.

Though this is a County facility, it is situated in the City of Los Angeles, which has a Protected Tree Ordinance in place to discourage the removal of native trees and shrubs. The fact that the Tar Pits are a County facility is insufficient reason to ignore City law supported by the stakeholders of the community. **NCSA-20** The existing site contains multiple healthy mature specimens of these five protected tree species (*Heteromeles arbutifolia* (Toyon), *Platanus racemosa* (Western Sycamore), *Umbellularia californica* (California Bay Laurel), *Sambucus mexicana* (Blue Elderberry), and *Juglans californica* (Southern California Black Walnut)) and one protected tree genus *Quercus* (Oaks) of native origin as defined in Los Angeles Ordinance 186873. Many of these are slated for removal. **NCSA-21** The project site is noteworthy for having all these species in a relatively small area that is easily walkable and accessible, and **NCSA-22** consequently serves as an extremely valuable education tool in addition to having the biodiversity benefits these native trees provide. Section 3.4.7.1 of the DEIR estimates that 135 to 180 trees (including many non-native trees) in the existing site will be removed, assuming the calculation that an additional 10 percent will be relocated. This is a significant loss of mature tree canopy for the community, with decades-long loss of shade, carbon capture, and heat-island effect offset. Installing the full 4:1 replacement ratio of our protected species on site as part of the new design is an important long term mitigation to these losses. **NCSA-22 (cont'd)**

4) The removal of any ***Berberis nevinii*** (Nevin's Barberry) should also result in a 4:1 replacement ratio planted on site within the project boundaries.

Berberis nevinii is a federally and state listed endangered species. Several large, mature examples of this shrub are at the existing site, specifically within the current Pleistocene garden—an area slated for removal in current plans. Though these plants were planted by humans, they are well established at the location. The new plant palette designs in Figures 3-12, 3-13, and 3-14 of the DEIR do not include plans for *Berberis nevinii*. While relocation of the existing on site mature shrubs is technically possible, this may have a low success rate beyond the short term. By incorporating new plantings of this species into the design, a long term presence for this endangered species can be secured. **NCSA-23**

5) All new plantings, other than functional lawn, must be native species, with a preference for species from the tar pits fossil record. **NCSA-24**

The original vision of this park as articulated by naturalist Theodore Payne and landscape architect Ralph Cornell over a century ago was to feature an exclusively native plant habitat. This project offers a singular opportunity to bring that vision closer to reality, and there are extremely important reasons to do so. Los Angeles is experiencing a biodiversity crisis, having lost over 90% of our local pollinators since the beginning of the twentieth century. Key Lepidoptera species (butterflies and moths) are disappearing to extinction at the rate of two regional species per year. Because many specialist fauna depend on the native plants with which they have evolved, native landscaping plants and trees provide essential support for local biodiversity. There is not a better case for an all-native urban landscaping design than that of Hancock Park in the La Brea Tar Pits Master Plan Project, a space noteworthy for being the most important Pleistocene fossil site on the planet. The tar pits have established a fossil record with tens of thousands of years of evidence of our native plants surviving climate change and varying carbon levels that exceed those anticipated from anthropogenic climate change. These changes were a factor in wiping out the famous megafauna displayed in the Page Museum at the tar pits, yet our surviving local native plants endured these changes. **NCSA-25**

As a demonstration of the power of adaptability within the DNA of our local native plants in our unique biodiversity hotspot, the project site has unparalleled importance as an education tool for climate change and biodiversity, but only if the landscaping design utilizes those native plant species. Happily, the creators of the DEIR document seem to get this, as all the proposed species in Sections 3.4.7 and 3.4.7.1 and the aforementioned Figures of the DEIR exclusively reference native species. However, suggested plant palettes are different from actual detailed landscaping plans. **NCSA-26** In conversations with several members of the landscape design team, our members were repeatedly told that new landscaping installations would be "90 to 95 percent native" with some members of the design team going on to mention plans to install multiple exotic trees such as *Tipuana tipu*. There is no scientific, cultural, or practical justification for including non-native tree species in the planting palette of this project. With well over 70 locally native tree and shrub species and hundreds of local herbaceous plant species providing ample choices for both drought resistant landscaping as well as the project's riparian biofiltration areas, no credible argument can be made that it is biologically valuable or necessary to add more ornamental non-native species to this site (a site that will still contain over 100 mature non-native trees slated for preservation in the current plan). **NCSA-27**

Furthermore, even the "90 to 95 percent" natives suggested by designers is greatly misleading. Consider that a large percentage of the 13 acres in both the existing site and proposed site in the DEIR consists of non-native grass species for open lawn. Thus, the native percentage estimate by designers omits the lawn that will constitute the highest percentage of planted biomass for the project. While lawn has a functional green space value for the community, the ornamental landscaping trees and other non-lawn plants added to this site, going forward, should be exclusively native in recognition of the historical significance of the plants in the fossil record that make this site a true treasure for the local community, region, and world. **NCSA-27 (cont'd)**

Thank you for this opportunity for public comment. We hope the NCSA, an alliance that includes members with extensive ecological and native plant expertise, can serve as an advisor on this project as it moves forward. We applaud NHM for its ambitious goals in this exciting endeavor. **NCSA-28**

Sincerely,

The Neighborhood Council Sustainability Alliance of Los Angeles
www.ncsa.la

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† https://www.youtube.com/watch?app=desktop&v=LDdKOmvIKyg&feature=youtu.be

†† https://www.ecolandscaping.org/native-plants/

2.3.4.1 Response to Letter from Neighborhood Council Sustainability Alliance of Los Angeles

Comment No.	Response
NCSA-1	The commenter introduces the letter from the Neighborhood Council Sustainability Alliance (NCSA), indicating that the NCSA has concerns with the environmental impact of implementation of the master plan. The County would like to thank the commenter for participating in the public review process of the Draft EIR. A copy of this comment letter will be included in the Final EIR, which will be provided to the Board of Supervisors for review when the project is considered for approval. This comment is introductory in nature and does not provide a specific concern with the environmental analysis contained in the EIR, so no response is provided. Responses to specific concerns raised later in the letter are provided below. It is important to note that most of the comments in the NCSA letter do not state any concern or critique of the analysis contained within the EIR. However, the County is providing responses to the concerns raised to provide as much information and transparency to the commenter and interested parties as possible.
NCSA-2	The commenter states that the NCSA has voiced concerns to project representatives over the past two years, but the objections did not seem to influence the project. This is not a comment on the EIR; therefore, no response is necessary, and no changes to the EIR were determined to be necessary in response to this comment.
NCSA-3	The commenter questions why the Draft EIR was prepared without a tree inventory. Further, the commenter asks why the EIR provides no disclosure of which trees would be removed and which would be retained. The commenter indicates that these are standard elements of a CEQA document. Appendix N has been added to the Final EIR which provides the tree inventory completed by the design team for the project. Appendix N includes tree locations and species identification. The commenter is correct that the EIR does not provide identification of the exact trees to be removed through implementation of the project. However, the implication that this is required for a CEQA document is not correct. The project description for the EIR only needs to include the information necessary to come to conclusion regarding the potential for significant environmental impacts. The full range of potentially significant biological resource impacts, including those to trees, is provided in the EIR in Section 5.3, Biological Resources. The thresholds of significance address the full range of impacts that could occur with the project, including impacting tree specimens protected by local ordinances. In this case, the property is regulated by the County of Los Angeles. The environmental analysis regarding vegetation and local tree impacts that is contained in Section 5.3 of the EIR is an accurate assessment of the potential for significant environmental impacts regarding tree and vegetation removal and no changes to EIR are made through the Final EIR process. Refer to **MR-2, Impacts to Native and Mature Trees**. Throughout the comment letter, the NCSA requests specific adjustments to the landscaping plan that the commenter believes would improve the project. After receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including the NCSA, and refined the design of the improvements proposed at the La Brea Tar Pits site, including the landscaping plan and what features could be retained and/or protected and to what degree. As a result, the County has pursued development of a variation of the Master Plan for consideration by the Board of Supervisors. Refinements to the landscaping plan are continuing to be considered as the design evolves. Refer to **MR-1, Preferred Alternative,** and **MR-3, Use of Native Plants and Vegetation,** for more information regarding the updated designs, Refined Alternative 3 and the County's commitment to meet and exceed the regulatory requirements for impacts to native vegetation at the La Brea Tar Pits site.
NCSA-4	The commenter mentions that a representative of the NCSA Trees Committee had positive engagement with several design team members (e.g., Gruen Associates and members of the landscape design team) during the County's September 30th outreach event. Members of the design team also attended NCSA's October 1st Advocacy meeting. The County appreciates the input that NCSA has provided on the project to-date, and it is being considered throughout the design process. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-5	The commenter quotes an excerpt from Appendix B of the Draft EIR. Refer to response to comments NCSA-6 through NSCA-10 below. This is not a comment that raises issue with the contents of the environmental analysis in the EIR; therefore, no response is necessary, and no changes to the EIR were determined to be necessary in response to this comment.
NCSA-6	The commenter requests that all shade-producing trees should be retained rather than replaced. Refer to **MR-2, Impacts to Native and Mature Trees**. This comment does not critique the analysis contained in the EIR; rather, the commenter is noting that they disagree with the County's approach to the project. The exact trees to be removed through implementation of the project have not yet been determined. The County will prioritize the protection of existing trees, where appropriate. However, retention of trees may not be possible due to several issues related to feasibility of retention. These include the excavation requirements for construction of the building and the relative proximity of the trees to the new building location, planned park accessibility improvements, and fire access requirements. In addition, the County is planning to remove diseased or unhealthy trees from the park with implementation of the project. Newly planted trees would be selected for resilience to disease and with consideration for their ability to create shaded areas at the park.

Comment No.	Response
	While there may be short term reductions to the amount of available shade at the project site, this loss will be recouped once the newly planted trees grow and mature. Furthermore, by relying on native and disease-resistant species, the newly trees planted may prove to be more resilient than some of the existing trees on the project site, thus resulting in better shade production. The proposed removal of trees at the La Brea Tar Pits site is not considered a significant impact on the environment. The environmental analysis regarding impacts to tree that is contained in EIR Section 5.3, Biological Resources, is an accurate assessment of the potential for significant environmental impacts regarding tree and vegetation removal. Furthermore, any visual impacts related to tree removal is appropriately discussed within EIR Section 5.1 Aesthetics, which concluded a less than significant impact. The County will continue to refine the designs as the project develops to account for the most protections possible for native and community resources. This may include protection of individual tree species noted as important to the community and/or increases in replacement ratios for trees that are particularly valued by the community. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-7	The commenter provides additional information supporting their opinion that the existing trees at the project site should not be removed. Specifically, the commenter claims that according to Dr. Beverly Law, there is evidence that newly planted trees initially emit carbon, and only mature trees sequester carbon. Refer to **MR-2, Impacts to Native and Mature Trees**, and response to comment NCSA-6. This comment does not critique the analysis contained in the EIR; rather, the commenter is noting that they disagree with the County's approach to the project. The comment is correct that mature trees are important for their carbon sequestering abilities. As discussed in MR-2, the County will strive to prioritize the protection of existing trees, particularly those that are native species and/or mature, and would avoid their removal if feasible, while also meeting the budgetary and design needs for the project. However, many trees would not be able to be retained due to several project requirements, including, the excavation requirements for construction of the new building, the relative proximity of the trees to the new building location, planned park accessibility improvements, and fire access requirements. However, the comment's claim that new trees should be viewed as sources of carbon is inaccurate. According to the PBS video referenced by the comment, Dr. Beverly Law provides evidence that new *forests* may be net sources of carbon, and that mature *forests* sequester greater quantities of carbon. The study in questions takes the entire carbon cycle of the forest into account, including decomposition on the forest floor, and assumes that every tree in the forest is newly planted. The purpose of the study was to provide evidence that retaining old growth forests is a more effective means of carbon sequestration than planting new forests. As the trees within the project site exist in a built-up urban environment, comparing the impacts of tree replacement by the project to the replacement of an entire old growth forest is erroneous. There is no reliable evidence that suggests that planting new trees would increase carbon emissions. It is true that the carbon sequestration abilities of the site would be reduced by removing mature trees, however, these losses would be recouped as the new trees mature. Furthermore, by relying on native and disease-resistant species, the new trees planted by the project may prove to be more resilient than some of the existing trees on the project site, thus resulting in longer term carbon sequestration. The EIR found that the project's greenhouse gas impacts would be less than significant after implementation of Mitigation Measures GHG/mm-1.1 and TRA/mm-1.1. As the EIR does not rely on the project's carbon sequestration potential to make an impact conclusion, the potential short-term reductions in carbon sequestration are not relevant to the analysis included in the EIR. Therefore, no changes to the EIR were determined to be necessary in response to this comment.
NCSA-8	The commenter provides additional information supporting their opinion that the existing trees at the project site should not be removed. Specifically, the commenter references a quote from Appendix B of the DEIR and argues that the "character and unity" of the site should not be the deciding factor for tree removal. Refer to **MR-2, Impacts to Native and Mature Trees**, and response to comments NCSA-3 and NCSA-6. The quote referenced by the comment has been taken out of context. No trees are proposed to be removed solely because they do not add to the character and unity of the site. Instead, the quote is meant to demonstrate that there will be an emphasis on improving the character and unity of the site with the proposed new plantings. As discussed in MR-2, the County will strive to prioritize the protection of existing trees, particularly those that are native species and/or mature, and would avoid their removal if feasible, while also meeting the budgetary and design needs for the project. However, many trees would not be able to be retained due to several project requirements, including, the excavation requirements for construction of the new building, the relative proximity of the trees to the new building location, planned park accessibility improvements, and fire access requirements. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-9	The commenter quotes text in the Draft EIR that indicates that Western Sycamore, California Buckeye, and Redwood trees should be preserved but then indicates that a presentation on September 30 indicated that these native trees are not being preserved. In addition, the commenter further indicates that a tree inventory should be provided. The exact trees to be removed through implementation of the project have not yet been determined. The County will prioritize the protection of these trees and will avoid their removal if feasible while also meeting the budgetary and design needs for the project. Retention of all individuals of an important tree species may not be possible due to several issues related to feasibility of retention. These include the excavation requirements for construction of the building and the relative proximity of the trees to the new building location, planned park accessibility improvements, and fire access requirements. The County will continue to refine the designs as the project develops to account for the most protections possible for native and community resources. This may

Comment No.	Response
	include protection on individual tree species noted as important to the community and/or increases in replacement ratios for trees that are particularly valued by the community. Appendix N has been added to the Final EIR which provides the tree inventory completed by the design team for the project. Appendix N includes tree locations and species identification. It should also be noted that the project would result in an increase in the number of native trees at the project site. These native trees are more resilient and likely to survive and thrive over the long term as they are uniquely adapted to the local southern California climate. Refer to **MR-2, Impacts to Native and Mature Trees**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-10	The commenter indicates that the project should preserve valuable tree species to fulfill the project's dedication to educating the public about extinction. While this is not a comment specifically on the analysis contained in the Draft EIR, it should be noted that native species have been prioritized in the plant palette and incorporated into the design where appropriate. The plant palette was developed based on the native vegetation of the Los Angeles Basin and was informed by research gathered from the La Brea Tar Pits fossil record. Furthermore, it should be noted that the plant palette also contains considerations for historical floral communities and pollinator resources. The County and the project design team will continue to refine the designs as the project develops to account for the most protections possible for native resources. Refer to **MR-2, Impacts to Native and Mature Trees**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-11	The commenter provides additional feedback requesting the retention of shade-producing trees. Refer to **MR-2, Impacts to Native and Mature Trees,** and response to comments NCSA-6, NCSA-9, and NCSA-10. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-12	The commenter requests that all new plantings should be native species. While this is not a comment specifically on the project's environmental impacts as contained in the Draft EIR analysis, it should be noted that native species have been prioritized in the plant palette and incorporated into the design where appropriate. The plant palette was developed based on the native vegetation of the Los Angeles Basin and was informed by research gathered from the La Brea Tar Pits fossil record. Refer to **MR-3, Use of Native Plants and Vegetation.** No changes to the EIR were determined to be necessary in response to this comment.
NCSA-13	The commenter notes that there are specific adjustments to the landscaping plan that they believe will improve the sustainability, historical value, and cultural significance of the project. The commenters' specific comments are addressed in the following responses. After receiving comments on the Draft EIR, the County, considered the comments made by the commenting entities, including the NCSA, and refined the design of the improvements proposed at the La Brea Tar Pits site as reflected in Refined Alternative 3, including the landscaping plan and what features could be retained and/or protected and to what degree. As a result, the County will be recommending approval of Refined Alternative 3 by the Board of Supervisors. Refinements to the landscaping plan are continuing to be considered by the County as the design evolves. Refer to **MR-1, Preferred Alternative, MR-2, Impacts to Native and Mature Trees**, and **MR-3, Use of Native Plants and Vegetation**, for more information regarding the additional information provided by the updated designs, Refined Alternative 3 and the County's commitment to meet and exceed the regulatory requirements for impacts to trees and other vegetation at the La Brea Tar Pits site.
NCSA-14	The commenter shares the opinion that the bioswales included in the project (as described in the EIR) should be redesigned without an impermeable liner because the use of an impermeable liner limits the ability for the bioswales to recharge the site's groundwater. While this is not a comment on the environmental impact analysis contained in the EIR, additional information is provided within this response to provide an understanding of the rationale for the proposed bioswale approach. It is correct that the use of an impermeable liner would limit the bioswales ability to recharge groundwater. However, the proposed bioswale is intentionally designed this way. Further, groundwater recharge is not an objective of the proposed project. Due to the conditions of the project site, constructing a permeable bioswale would not be feasible. Bioswales relying on permeable basins require the composition of the local soil to allow for a high enough infiltration rate in order to avoid any standing water. This is because standing water can lead to vector control issues, by potentially providing a breeding ground for mosquitos and other harmful organisms. The project site's soil composition includes clays and tar sands which would not allow stormwater to infiltrate into the ground at a high enough rate to avoid standing water. As well, groundwater must not be found less than 10 feet from the bottom of the bioswale, in order to allow for adequate filtration to reduce the amount of surface pollutants entering the groundwater. Groundwater at the project site has been discovered less than 10 feet from the surface, which would not allow stormwater to be adequately filtered prior to entering the groundwater. Lastly, since the site's soil includes clays and tar sands, this composition would further limit the ability for stormwater to infiltrate into the ground at high enough rates to allow for adequate filtration. Given the soil and groundwater conditions at the project site, the most feasible option is the use of bioswales which rely on stormwater bioretention basins, as proposed by the project. These types of bioswales consist of a raised planter system with a retention basin and an underdrain. They can be designed to be permeable, however certain site conditions may require an impermeable barrier. For the proposed project, the bioswales would be required to include an impermeable liner for two reasons. First, due to the presence of high groundwater, if the bioswale did not include an impermeable liner, the underdrain could continuously capture

Comment No.	Response
	the site's groundwater leading to unnecessary discharge. Second, without an impermeable barrier, the tar seeps present in the site's soil could potentially enter and clog the drainage system, reducing the effectiveness of the bioswale. For these reasons, permeable bioswales are not possible on the project site. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-15	This comment states that the use of bioswales with impermeable liners would undermine the functionality of the project site. As discussed in NCSA-14, the bioswales on the project site must be designed with an impermeable liner. However, the bioswales proposed would still be able successfully capture significant amounts of stormwater runoff and would reduce the potential for surface pollutants to further contaminate any groundwater present at the project site. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-16	The comment indicates that overflow water from the proposed bioswales should be captured for re-use on the project site. The County requires that all captured stormwater must be re-used within 96 hours to reduce the potential for vector control issues, as discussed in NCSA-14. Since the project will be landscaped with low-water use plants, it is anticipated that the demand required for reused water would not be met. EIR Sections 5.9 Hydrology and Water Quality and 5.15 Utilities include analyses with the assumption that water on the project site would not be recycled. The EIR concluded that the project would have less-than-significant impacts to hydrology and water quality as well as utility and service systems, with the implementation of identified mitigation measures. Therefore, no changes to the EIR were determined to be necessary in response to this comment.
NCSA-17	The commenter requests that the landscaping plan be redesigned to save the four tree specimens that have been highlighted by the NCSA as having value to the community because of their age. Specifically, these are identified by the commenter as two old-growth Sugarbush, one old-growth Toyon, one California Buckeye. Appendix N has been added to the Final EIR which provides the tree inventory completed by the design team for the project. The location of the trees identified by the commenter can be found in this appendix, which includes tree locations and species identification. The exact trees to be removed through implementation of the project have not yet been determined. The County will prioritize the protection of these trees and will avoid their removal if feasible while also meeting the budgetary and design needs for the project. Retention of these trees may not be possible due to several issues related to feasibility of retention. These include the excavation requirements for construction of the building and the relative proximity of the trees to the new building location, planned park accessibility improvements, and fire access requirements. The County will continue to refine the designs as the project develops to account for the most protections possible for native and community resources. This may include protection on individual tree species noted as important to the community and/or increases in replacement ratios for trees that are particularly valued by the community. However, because the property is not regulated by the City of Los Angeles, the replacement ratios set by the City of Los Angeles is not required to be met. Los Angeles County does not require any replacement ratios other than for protected oak trees. If the removal of oak trees cannot be avoided, Mitigation Measures BIO/mm-6.1 and 6.2 provide for the replacement of oaks at a 2:1 ratio for each tree impacted. The County and the project design team will continue to refine the designs as the project develops to account for the most protections possible for native resources. This may include possible voluntary increases in replacement ratios. However, a specific replacement ratio is not required beyond the requirements specified in Mitigation Measure BIO/mm-6.1. The environmental analysis regarding vegetation and local tree impacts that is contained in Section 5.3 of the EIR is an accurate assessment of the potential for significant environmental impacts regarding tree and vegetation removal. Refer to **MR-2, Impacts to Native and Mature Trees**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-18	The commenter opines that a superior plan would have been to design around the California Bay Laurel and several mature Torrey Pines. Refer to **MR-2, Impacts to Native and Mature Trees**, and response to comment NCSA-17. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-19	The commenter reiterates their opinion that the four trees listed in comment NCSA-17 be saved. Refer to **MR-2, Impacts to Native and Mature Trees**, and response to comment NCSA-17. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-20	The commenter indicates that the City of Los Angeles Ordinance 186873 should be followed, which would result in different replacement ratios than what is being proposed or required for the project. Wherever possible, the County will provide for higher replacement ratios than what is required by the regulatory requirements that apply to the project. However, the requirements set by the City of Los Angeles do not apply to the project, as the property is subject only to the regulatory requirements of the County of Los Angeles. The County and the project design team will continue to refine the designs as the project develops to account for the most protections possible for native resources. This may include possible voluntary increases in replacement ratios. However, the requirements identified in the EIR are not required to be revised as they are consistent with the regulatory requirements that apply to the project and what is necessary to reduce impacts to mature trees to less than significant. These measures are included in the EIR as Mitigation Measures BIO/mm-5.2, BIO/mm-6.1, and BIO/mm-6.2. No changes to the EIR were determined to be necessary in response to this comment.

Comment No.	Response
NCSA-21	The commentor references several tree species that they indicate should be protected. Refer to **MR-2, Impacts to Native and Mature Trees**, and response to comment NCSA-20. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-22	The commenter indicates that the project site is noteworthy for having many identified tree species in a relatively small area and consequently serves as a valuable education tool. Further, the commenter indicates that Section 3.4.7.1 of the DEIR estimates that 135 to 180 trees (including many non-native trees) in the existing site would be removed, assuming the calculation that an additional 10% would be relocated. After receiving comments on the Draft EIR, the County considered the comments made by the commenting entities, including NCSA, and refined the design of the improvements proposed at the La Brea Tar Pits site, including the landscaping plan and what features could be retained and/or protected and to what degree. As a result, the County will be recommending approval Refined Alternative 3. Refinements to the landscaping plan are continuing to be considered by the County as the design evolves; the specific trees to be removed has not been finalized. Refer to **MR-1, Preferred Alternative** for more information regarding the additional information provided by the updated designs and Refined Alternative 3. The County agrees that the site is noteworthy for having all these species in a walkable and accessible park setting. The County will prioritize the protection of important trees and will avoid their removal if feasible while also meeting the budgetary and design needs for the project. However, retention of specific trees may not be possible due to several issues related to feasibility of retention. These include the excavation requirements for construction of the building and the relative proximity of the trees to the new building location, planned park accessibility improvements, and fire access requirements. The County will continue to refine the designs as the project develops to account for the most protections possible for native and community resources. It should also be noted that the project would result in an increase in the number of native trees at the project site. These native trees are more resilient and likely to survive and thrive over the long term as they are uniquely adapted to the local southern California climate. Refer to **MR-2, Impacts to Native and Mature Trees**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-23	The commenter expresses that any removal of Nevin's Barberry should be replanted with a 4:1 replacement ratio. There are two Nevin's Barberry on site located in the Pleistocene Garden, which are proposed to be removed to accommodate grade changes for building and park improvements and the addition of a fire lane. However, this species can be included in the plant palette and incorporated into the design where appropriate. The requirements set by the City of Los Angeles do not apply to the project, as the property is subject only to the regulatory requirements of the County of Los Angeles. Los Angeles County does not require any replacement ratios other than for protected oak trees. If the removal of oak trees cannot be avoided, Mitigation Measures BIO/mm-6.1 and 6.2 provide for the replacement of oaks at a 2:1 ratio for each tree impacted. The County and the project design team will continue to refine the designs as the project develops to account for the most protections possible for native resources. This may include possible voluntary increases in replacement ratios. However, a specific replacement ratio is not required beyond the requirements specified in Mitigation Measure BIO/mm-6.1. The environmental analysis regarding vegetation and local tree impacts that is contained in Section 5.3 of the EIR is an accurate assessment of the potential for significant environmental impacts regarding vegetation removal. Refer to **MR-3, Use of Native Plants and Vegetation**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-24	The commenter requests that all new plantings be native species, with a special preference for species found in the tar pits fossil records, as the park was originally envisioned to exclusively feature native plants. While this is not a comment specifically on the project's environmental impacts as contained in the Draft EIR analysis, it should be noted that native species are prioritized in the plant palette and incorporated into the design where appropriate. The plant palette was developed based on the native vegetation of the Los Angeles Basin and was informed by research gathered from the La Brea Tar Pits fossil record. The County and the project design team will continue to refine the designs as the project develops to account for the most protections possible for native resources. Refer to **MR-3, Use of Native Plants and Vegetation**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-25	The commenter states that it is critical that native plants are incorporated in the project's design as Los Angeles is currently experiencing a biodiversity crisis. As discussed in Response NCSA-24, native plants have been prioritized in the plant palette, and specifically highlight plants which are present in Tar Pits fossil record. Furthermore, it should be noted that the plant palette also contains considerations for historical floral communities and pollinator resources. The County and the project design team will continue to refine the designs as the project develops to account for the most protections possible for native resources. Refer to **MR-3, Use of Native Plants and Vegetation**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-26	The commenter emphasizes that the project site has unparalleled importance as an education tool for climate change and biodiversity, but only if the landscaping design utilizes those native plant species. The commenter also expresses a concern that the final landscaping plans may differ from the proposed plant palettes, which primarily feature native plants. Refer to **MR-3, Use of Native Plants and Vegetation**, and Responses NCSA-24 and NCSA-25. The plant palettes included in Chapter 3 of the EIR are the palettes that were provided by the County and the design team, and they are continuing to be used as a guide for the detailed landscaping design plans. As previously

Comment No.	Response
	noted, native plants are prioritized in the plant palette and considerations for historical floral communities and pollinator resources are being incorporated in the project's landscaping design plans. Refinements to the landscaping plan are continuing to be considered by the County as the design evolves. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-27	The commenter notes that they were provided information that new landscape installations would include 90 to 95% natives. As the design process develops, the exact percentage of natives to be installed will be finalized. California native plants and trees have been prioritized in the project's landscaping plan. However, for practical reasons a limited quantity of adapted species that are not native would be included in some areas of the site. It is correct that the estimates excluded the open lawn areas. However, this comment does not change the findings or conclusions in the Draft EIR; no revisions to the EIR are necessary because of this comment. Refer to **MR-3, Use of Native Plants and Vegetation**. No changes to the EIR were determined to be necessary in response to this comment.
NCSA-28	The commenter closes the letter and states that the NCSA hopes to serve as an advisor to the project as it moves forward. The County appreciates the input that NCSA has provided on the project to-date and it is being considered throughout the design process. No changes to the EIR were determined to be necessary in response to this comment.

2.3.5 Park La Brea Impacted Residents Group

PLBIRG PARK LA BREA IMPACTED RESIDENTS GROUP

VIA EMAIL

October 26, 2023

Leslie Negritto
COO
Natural History Museums of Los Angeles County
900 Exposition Boulevard
Los Angeles, CA 90007

Re: Natural History Museums of Los Angeles County ("NHMLAC")
La Brea Tar Pits Master Plan Project (the "Project")
(SCH # 2022020344)

Dear Ms. Negritto:

Park La Brea Impacted Residents Group (PLBIRG) is watchdog group of Park La Brea residents focused on land use / public safety matters on the Park La Brea perimeter which is across the street from the Project. These are our comments in response to the Project's Draft Environmental Impact Report (DEIR).

Overall we're pleased about the plans to update and enhance the Tar Pits campus and our comments are primarily related to grave concerns over the lack of safe pedestrian accessibility to the Project where the public frequently enters and exit the Tar Pits campus (the "Campus") midblock on the Curson perimeter. **PLBIRG-1**

Based on renderings in the DEIR it appears that the Project will retain one of the current pedestrian entrances, directly opposite the One Museum Square apartment tower. **PLBIRG-2**

As NHMLAC knows, or should know, there is a long history, well documented, of the public crossing midblock between the east and west sides of Curson to enter/exit the Campus via the Campus's midblock pedestrian entrances. The Project proposes to expand and "reimagine" the Tar Pits campus which will almost certainly attract even larger volumes of visitors in the future, with a related increase in staffing to serve the expanded facilities and visitor volume. That would exacerbate the existing pedestrian hazard. **PLBIRG-3**

The Curson midblock pedestrian hazard must be mitigated. **PLBIRG-4**

351 S. Fairfax Avenue #421 Los Angeles, CA 90036 (323) 955-0475 info@plbirg.org

PLBIRG
Comments on Tar Pits DEIR

On January 3, 2018 I submitted **MYDOT #93857** to Los Angeles Department of Transportation (LADOT) asking that LADOT install a midblock pedestrian crosswalk after I documented on a cold winter afternoon in January, in the space of a mere 27 minutes, 137 people crossed between the east and west sides of Curson in the vicinity of the Tar Pits midblock pedestrian entrance.

Had I stayed a full hour to continue photo-documenting, the total would likely have exceeded 275 crossings in an hour, *more than 10 times the volume needed to meet LADOT's 20 per hour benchmark* to justify a midblock crosswalk.

PLBIRG-5

I provided this photo gallery capturing the 137 crossings in 27 minutes to LADOT, CD4 and LA County and LACMA officials including Katy Young Yaroslavsky, Sheila Kuhel, Stephanie Cohen, Doug Leonhardt, and Timothy Lippman. I noted that fully 100% of the midblock pedestrian crossings involved museum campus visitors or employees. The County knew that their patrons and employees were in harm's way.

Unfortunately no action was taken, despite multiple attempts by PLBIRG to follow up. High ranking Tar Pits staff confided that they, too, crossed midblock when making a quick trip to the SAG building to get food or coffee. In 2022 we reached out to the Reimagining Team (Jesse Rocha) to make the new team aware of these issues. We were very disappointed that the DEIR was silent on the known history of unsafe pedestrian crossings on the Curson perimeter.

PLBIRG-6

Among those seen in the photo gallery were babies, toddlers, elderly in wheelchairs, and interestingly enough, quite a few County employees headed to and from getting food in the SAG building. These were all familes and individuals who patronized and or worked at the County's museum campus.

PLBIRG-7

PLBIRG is cognizant that crosswalks on public streets are the purview of the City, not the County. However, it is incumbent on NHMLAC to recognize that they are putting the public in harm's way by placing a mid block pedestrian entrance on Curson directly opposite two different high density apartment buildings (Museum Terrance and One Museum Square), the SAG public parking structure, which is patronized by Tarpits visitors, and multiple restaurants whose rear entrances/exits are opposite the Tarpits midblock entrance. The entrance's midblock position invites midblock crossing.

No amount of wishful thinking has ever or will ever persuade these residents, Tarpits visitors and SAG bulding patrons to walk to the corner to use the signalized crosswalks at Sixth or Wilshire. When someone emerges from their buiding opposite the entrance to their destination, it's a tough sell to convince them to walk half a block up to the corner to cross the street only to circle back to be directly opposite from where they started out.

PLBIRG-8

3

For reference, in 2017, I submitted a crosswalk request to LADOT in connection with the Tarpits' Spaulding gate entrance on Sixth Street after a 67 year old grandmother was fatally struck crossing midblock with her 5 year old grandson from the north side of Sixth to enter the museum campus. We photodocumented the high level of midblock crossings at that entrance as well. The Spaulding / Sixth crosswalk was finally installed in the summer of 2019 after three years of my and my neighbors' advocating for it, in 2019. In this case, our reaching out to Katy Young, who was the Arts Deputy at the time, led to Katy helping to secure partial funding from LACMA to pay for the crosswalk. We faced the same exact issue that is before you now: these are City governed streets by the pedestrians are County facility patrons who need safe access and egress to and from those facilities. PLBIRG-9

This forseeable and abundantly documented hazard must be mitigated as part of any "Reimagining" of the Tar Pits, to protect the public. PLBIRG-10

Sincerely,

Barbara Gallen
Co-President
PLBIRG

2.3.5.1 Response to Letter from Park La Brea Impacted Residents Group

Comment No.	Response
PLBIRG-1	The comment serves as an introduction to the comment letter and the Park La Brea Impacted Residents Group (PLBIRG). The introduction to the letter indicates that the organization is pleased, overall, with the plans to update and enhance the site. However, the PLBIRG has concerns regarding safe pedestrian accessibility, which are further expanded upon in the remainder of the letter. The County would like to thank the commenter for participating in the public review process of the Draft EIR. A copy of this comment letter will be included in the Final EIR, which will be provided to the Board of Supervisors for review when the project is considered for approval. This comment is introductory in nature and does not provide a specific concern with the environmental analysis contained in the EIR, so no response is provided. Responses to specific concerns raised later in the letter are provided below.
PLBIRG-2	The commenter describes a rendering that shows that the project maintains the current pedestrian entrance along Curson Avenue. This comment is consistent with the information presented in the EIR; no additional response is necessary, and no changes to the EIR were determined to be necessary in response to this comment.
PLBIRG-3	The commenter indicates that there are high volumes of pedestrians crossing along Curson Avenue at the midblock location between 6th Street and Wilshire Boulevard. The commenter provides further input indicating that they believe the project would encourage more pedestrians to cross at midblock because of an increase in visitor volume. The EIR considers environmental impacts based on thresholds established consistent with Appendix G of the State CEQA Guidelines. Specifically, the most relevant thresholds are outlined in the EIR in Section 5.13.3, Transportation, Thresholds of Significance. Consistent with this analysis methodology, a potentially significant transportation impact could occur if one of the following criteria were to be met: • The project would cause a conflict with a program, plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities. • The project would substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment). Proposed changes to the circulation system resulting from the project would not cause the hazards that the commenter believes currently exist. While the proposed project would likely increase the number of people who visit the site each day, there is no evidence that this would directly lead to an increase of pedestrians choosing to cross Curson Avenue at the midblock section rather than at an existing crosswalk facility. Overall, the improved circulation system proposed by the project would encourage visitors to enter and exit the site in proper locations located immediately near existing crosswalk facilities. The renovated Wilshire Avenue and 6th Street gateway entrances would encourage visitors to use the existing crosswalk facilities at the southeast and northwest corners of the site. Specifically, the improved visibility of the renovated Wilshire gateway entrance would likely decrease the number of visitors accessing the site from Curson Avenue. The project also proposes a new school drop-off area immediately in front of the Curson Avenue entrance. This drop-off area would further discourage pedestrians from attempting to access the site through the Curson Avenue entrance and would potentially disrupt illegal pedestrian crossings. Additionally, the existing Page Museum entrance would be primarily used as an educational group and tour entrance, which would be connected to the new school drop-off area on South Curson Avenue. This is expected to discourage visitors from exiting the site using the Curson Avenue entrance, and therefore would further reduce the potential for illegal pedestrian crossings on Curson Avenue. As such, the combination of the renovated gateway entrances and the proposed school drop-off zone would discourage any new visitors generated by the project from attempting to enter the project site by illegally crossing Curson Avenue. For this reason, no changes to the EIR were determined to be necessary in response to this comment.
PLBIRG-4	The commenter indicates that the existing Curson Avenue midblock pedestrian condition should be addressed because the commenter views it as a hazardous condition. Refer to response to comment PLBIRG-3. The suggestion for a midblock pedestrian crossing at the pedestrian entrance along Curson Avenue was considered by the County. This type of crossing could conflict with bus loading curb space on the west side of Curson Avenue. As well, the curvature of the road along Curson Avenue north of Wilshire Boulevard and south of the pedestrian entrance may pose a potential northbound vehicle site distance issue as this location is very close to the merging area north of Wilshire Boulevard where two streams of northbound vehicles merge. Driveways and utilities also act as a barrier to placement of a safe crossing facility in this location. Additionally, placement of a pedestrian crossing further north along Curson Avenue may also be infeasible because a crossing in this location would conflict with bus loading curb space on the west side of Curson Avenue and the presence of driveways and utilities would also be problematic to designing a safe crossing facility in this location. The City of Los Angeles could choose to examine this concern more closely, which the County would support. The environmental analysis contained in Section 5.13 of the EIR is an accurate assessment of the potential for significant environmental impacts regarding transportation and hazardous intersection. Implementation of the project would not change the existing conditions of the Curson Avenue midblock crossing; therefore, the project would not cause a transportation impact related to hazardous conditions for pedestrians. No changes to the EIR were determined to be necessary in response to this comment.

Comment No.	Response
PLBIRG-5	This comment provides an observation of midblock pedestrian crossing volumes and an assertion that the observed volumes exceed LADOT standards for installing a pedestrian improvement. See responses to comments PLBIRG-3 and PLBIRG-4. In addition, it should be noted that the midblock location in question does not exhibit a history of accidents involving pedestrians and vehicles. According to the Transportation Injury Mapping System (TIMS), which is a database of California crash data, there was one midblock pedestrian crash for the 10-year period between 2013 and 2022. The crash occurred 110 feet south of the intersection with 6th Street, north of the location being referenced in this comment letter. In addition, this segment is not included as part of the City's high injury network, which is the focus of LADOT's comprehensive safety improvements where the highest concentration of traffic deaths and severe injury crashes occur. Refer to response to comments PLBIRG-4. No changes to the EIR were determined to be necessary in response to this comment.
PLBIRG-6	This comment asserts that there are significant pedestrian crossing volumes at the midblock location along Curson Avenue, and that the EIR should include analysis of the pedestrian crossing at this location. See responses to comments PLBIRG-3, PLBIRG-4, and PLBIRG-5. Implementation of the project would not change the existing conditions of the Curson Avenue midblock crossing; therefore, the project would not cause a transportation impact related to hazardous conditions for pedestrians. Further, a midblock pedestrian crossing at the location proposed by the commenter is likely not feasible (response to comment PLBIRG-4). Also, the location in question does not exhibit a history of documented pedestrian-related accidents (response to comment PLBIRG-5). No changes to the EIR were determined to be necessary in response to this comment.
PLBIRG-7	The commenter provides additional information regarding their observations of pedestrians crossing Curson Avenue at midblock. See responses to comments PLBIRG-3, PLBIRG-4, and PLBIRG-5. Implementation of the project would not change the existing conditions of the Curson Avenue midblock crossing; therefore, the project would not cause a transportation impact related to hazardous conditions for pedestrians. Further, a midblock pedestrian crossing at the location proposed by the commenter is likely not feasible (response to comment PLBIRG-4). Also, the location in question does not exhibit a history of documented pedestrian-related accidents (response to comment PLBIRG-5). No changes to the EIR were determined to be necessary in response to this comment.
PLBIRG-8	The commenter acknowledges that crosswalks on adjacent streets are under the jurisdiction of the City of Los Angeles. However, the commenter further expresses that PLBIRG believes that the Natural History Museum should recognize that they are putting the public in harm's way because PLBIRG believes that a hazardous condition exists for pedestrians crossing Curson Avenue at midblock. See responses to comments PLBIRG-3, PLBIRG-4, and PLBIRG-5. Implementation of the project would not change the existing conditions of the Curson Avenue midblock crossing; therefore, the project would not cause a transportation impact related to hazardous conditions for pedestrians. Further, a midblock pedestrian crossing at the location proposed by the commenter is likely not feasible (response to comment PLBIRG-4). Also, the location in question does not exhibit a history of documented pedestrian-related accidents (response to comment PLBIRG-5). No changes to the EIR were determined to be necessary in response to this comment.
PLBIRG-9	The commenter recounts an experience where LACMA coordinated with the City of Los Angeles to install a crossing along 6th Street which was requested due to a pedestrian fatality. See responses to comments PLBIRG-3, PLBIRG-4, and PLBIRG-5. Implementation of the project would not change the existing conditions of the Curson Avenue midblock crossing; therefore, the project would not cause a transportation impact related to hazardous conditions for pedestrians. Further, a midblock pedestrian crossing at the location proposed by the commenter is likely not feasible (response to comment PLBIRG-4). Also, the location in question does not exhibit a history of documented pedestrian-related accidents (response to comment PLBIRG-5). No changes to the EIR were determined to be necessary in response to this comment.
PLBIRG-10	The commenter concludes the letter by indicating again that there is an existing hazard to pedestrians crossing at midblock on Curson Avenue and requests the implementation of improvements. See responses to comments PLBIRG-3, PLBIRG-4, and PLBIRG-5. Implementation of the project would not change the existing conditions of the Curson Avenue midblock crossing; therefore, the project would not cause a transportation impact related to hazardous conditions for pedestrians. Further, a midblock pedestrian crossing at the location proposed by the commenter is likely not feasible (response to comment PLBIRG-4). As well, the location in question does not exhibit a history of documented pedestrian crashes (response to comment PLBIRG-5). No changes to the EIR were determined to be necessary in response to this comment.