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Daniel S. Cooper
Resource Conservation District- Santa Monica Mountains, dcooper@rcdsmm.org

Nurit D. Katz
University of California, Los Angeles, nkatz@fm.ucla.edu

Morgan L. Rogers
University of California, Los Angeles, mrogers19@g.ucla.edu

Fiona M. Osborn
University of California, Los Angeles, fosborn@g.ucla.edu

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Assessing and Improving the Ecological Function of Linear Parks Along the Lower Los Angeles River Channel, Los Angeles County, California, US

Long overlooked by conservation groups and ecologists, urban open spaces are now seen as important contributors to biodiversity at various scales. Urban greenspaces often represent the only "nature" millions of human residents around the world ever interact with, and provide cooling and aesthetic relief from the urban hardscape. In the Los Angeles Metropolitan area, over the past three decades, non-profit advocacy groups and institutions have established a network of bike paths, neighborhood access points, habitat restoration, and recreational amenities along the Los Angeles River, a major urban waterway. We investigated the environmental contribution provided by numerous linear landscaped parks along the river, focusing on climate amelioration (i.e., cooling within heat islands) in the parks and surrounding neighborhoods, and on their contribution to local biodiversity, utilizing an indicator species approach. We conducted plant surveys of the parks, documenting locally native, non-local California native, and non-native species, and examined the occurrence of 15 riparian indicator species of wildlife in the parks and in 500-meter buffer zones surrounding each park utilizing citizen science data. We then explore correlations between indicator species richness and environmental variables. We note important occurrences of relict riparian vegetation in several linear parks, as well as both planted and naturally-occurring special-status plant and wildlife species. Finally, we discuss challenges to managing natural habitat in highly-urban parks, many of which support important relict vegetation and/or special-status species, and offer suggestions on how they may be improved.

Keywords

Ecological Function, Los Angeles River, Cooling Impact, Climate Resilience, Biodiversity, Urban Ecology, Parks Management

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1 INTRODUCTION

Long overlooked by conservation groups and ecologists, urban green spaces are now seen as important contributors to biodiversity at various scales (Soanes et al. 2018, Riva and Fahrig 2021, Uchita et al. 2021). Urban parks and small greenspaces often represent the only nature millions of urban residents around the world ever interact with. Park access corresponds to improved health outcomes, quality of life, and life expectancy for human residents (Jimenez et al. 2021, Connolly et al. 2023) and lack of exposure to biodiversity may result in a degradation of environmental knowledge and understanding (Aminpour et al. 2022). Moreover, urban green spaces can provide potential cooling benefits for urban residents, by reducing urban heat island effects (UHI) (Aram et al., 2019). Urban land features such as buildings, asphalt and concrete have lower albedo profiles, which means they absorb more heat throughout the day and slowly release it, making it hotter than undeveloped, vegetated areas (Oke 1982, Arnfield 2003). Meanwhile, vegetation, water and higher-albedo surfaces reflect more sunlight; thus, less heat is absorbed in comparison to say asphalt, which is why cities are seeking ways to increase green cover and high-albedo surfaces to address UHI (Bowler et al., 2010; Erell et al., 2014).

Ecologists are only beginning to explore how native species form novel ecosystems in urban environments, and how changes to the structure, composition and origin of urban vegetation might influence wildlife species diversity and persistence (Kennedy et al. 2018). Links between local ecosystem function and biodiversity patterns within overwhelmingly urban areas remain poorly-documented, despite a surge in recent research (Rega-Brodsky et al. 2022). Los Angeles represents an ideal setting for exploring and executing approaches to urban biodiversity conservation, with its large and diverse population, varied urban forms, and diverse ecosystems coinciding with a global biodiversity hotspot (Brown 2017, Reid-Wainscoat et al., 2021). Recent research here has shown that biodiversity in urban Los Angeles appears to correlate with multiple factors; bird species richness appears to be influenced by complexity in urban built form (Rogers 2022), amount of undeveloped land and park size (Vazquez 2021), and the presence of specific tree species favored by local birds (Wood and Esaian 2020). However, other (non-bird) wildlife respond to different factors, such as moderate mean temperature, e.g., Phorid fly diversity (McGlynn et al. 2019).

Bisecting the Los Angeles Basin and flowing for more than 80 km from the foothills to the Pacific Ocean, the Los Angeles River was channelized (and largely paved-over) nearly 100 years ago to control unpredictable flooding, and to enable residential development in the San Fernando Valley and coastal plain of Los Angeles (**Figure 1**; Gumprecht 2001). In recent decades, in-channel flow, particularly summer flow, has increased greatly with the establishment of water treatment plants and urban runoff which create a year-round (if anthropogenic) water source. At the same time, changes in management practices have allowed a visually interesting and ecologically significant mix of natural and quasi-natural wetland and riparian habitat to develop in three areas along the channel: Sepulveda Basin (**Figure 1**), Glendale Narrows/Elysian Valley, and the Long Beach estuary (Stein et al. 2021, Cooper et al. 2022). However, the majority of the river is channelized on the banks and floor, with strips of undeveloped land bordering the channel being the only “open space” associated with the river. Since the 1980s, these strips have been converted to parkland use as the river is framed as more of an urban amenity than an eyesore or a threat, with various non-profit advocacy groups and institutions succeeding in establishing bike paths, neighborhood access points, habitat restoration, and recreational amenities within these undeveloped strips (Feldman 2018). Numerous local and federal agencies are now leading the push to restore and beautify the river channel (e.g., LADPW 2004), and major funding for these projects has been earmarked in the form of state bond measures and federal grants (Gottlieb and Azuma 2005).

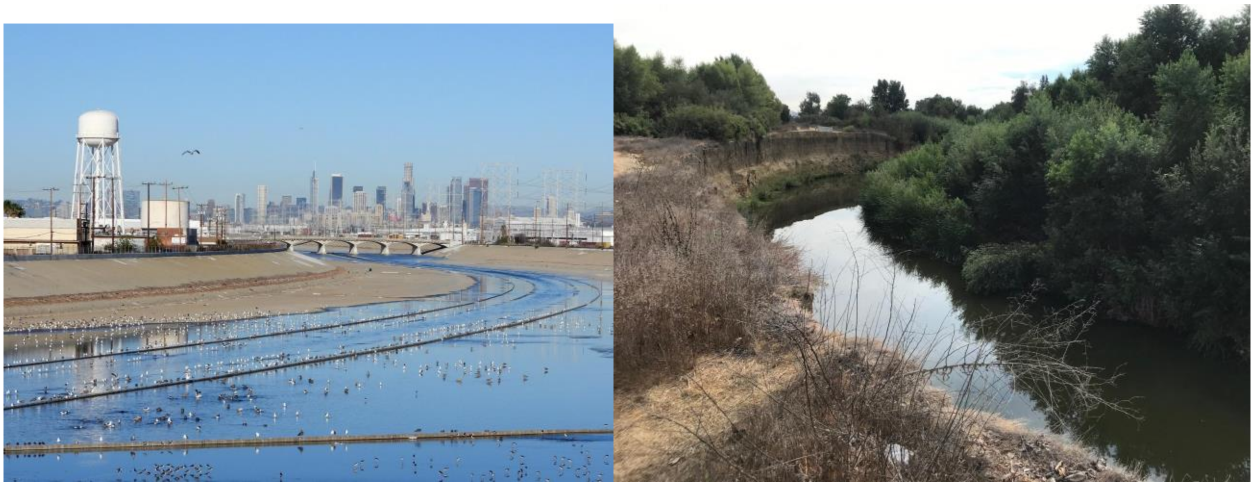


Figure 1. Channelized Los Angeles River vic. Vernon, with Downtown Los Angeles in background. (Left) Photo by Nurit D. Katz. Los Angeles River, showing un-channelized portion (including eroding bank) through Sepulveda Basin. (Right) Photo by Daniel S. Cooper.

In 2010, Assembly Bill 1147 resulted in the establishment and landscaping of numerous linear parks along the Los Angeles River and its tributaries (a handful of linear parks had been established prior to this, starting in the 1990s). These linear parks – locally called “pocket parks” (e.g., Bullard 2005) – are comprised of strips of vacant land atop and just outside the levee walls of the channel, planted with vegetation and featuring decorative hardscape (e.g., boulders, naturalistic water features, etc.) intended to resemble or at least reference the in-channel and historical flora and ecological conditions (**Figure 2**). The stated purpose of these recent park projects has been three-fold, depending on the site, with emphasis on habitat restoration, human recreation, and/or simple parkland preservation. Yet despite considerable ongoing research into ways to restore habitat along the river channel and the development of priorities for conservation over the past two decades (e.g., Stein et al. 2021), existing linear park projects have never been critically assessed in terms of their ecological contribution and efficacy, including their urban cooling function or their ability to support native biodiversity, nor have ecologists suggested ways they might be improved.

Figure 2. Los Angeles River linear parks vary in size, orientation, and amount of native landscaping. (Left) “Los Angeles Riverfront Greenway” in Sherman Oaks neighborhood of San Fernando Valley. Many linear parks feature narrow plantings along walkways and bicycle paths. Photo by Nurit D. Katz. (Right) Aerial view of North Atwater Creek Restoration (yellow outline), one of the larger and more natural parks assessed in the study, located between a typical urban park (with lawn and athletic fields) and the vegetated Los Angeles River channel, at left.

We used remote sensing data from USGS Landsat 8 Collection to assess the contribution of several dozen linear parks to climate amelioration (i.e., cooling within heat islands) in the surrounding neighborhoods. We analyzed their contribution to local biodiversity by inventorying flora (including both planted and naturally-occurring species) of the parks and comparing both avian species richness and the presence of indicator species in and around each park site. Based on these findings and observations, we discuss ways in which these linear parks are variously succeeding to recreate habitats of the Los Angeles River watershed, and how they may be improved through small changes in management.

2 METHODS

2.1 Park Selection

Of the c. 50 projects listed in the Los Angeles River AB 1147 Project Plan as funding targets for park enhancement and creation under AB 1147 (LADPW, 2019), we identified 28 sites along the Los Angeles River channel and major tributaries that appeared to be linear parks – built (or planned) atop or just outside the channel levees – excluding very large parks that simply happened to border to the river without an attempt at native landscaping (e.g., Reseda Park, Maywood Riverfront Park). We also surveyed three additional linear parks contiguous with other AB 1147 parks but not included in the funding list, Anza Trail (Studio City) area, and Cressa Park and 34th St. Greenbelt in Long Beach, for a preliminary total of 31 parks. (See **Appendix Table S1a** for full site list). During late 2021 and early 2022, we performed rapid-assessment field visits, performing single-visit plant surveys at 20 of the sites, and confirmed that 15 of these parks had been completed/landscaped and were open to the public, and therefore could be analyzed using community-science data (**Table 1**). The remainder were at some stage of construction (or had not been started) and remained fenced-off vacant lots with locked gates and no obvious legal public access.

Table 1. Final list of focal parks. These are all developed, accessible linear parks along the Los Angeles River channel assessed in this study. "X" indicates categories under AB 1147 applied formally to the parks in the application process.

Park Name	City	AB1147 Habitat Restoration	AB1147 Recreation	AB1147 Parkland	Area (acres)
Albion/Downey Rec Center	Los Angeles		X	X	8.81
Anza Trail/Weddington Golf Course Edge	Los Angeles	N/A	N/A	N/A	1.38
Atwater Village West River Park	Los Angeles		X		4.91
DeForest Wetland Restoration	Long Beach	X	X	X	31.43
Dominguez Gap Wetlands	Long Beach	X	X	X	34.32
Drake-Chavez Greenbelt	Long Beach	X	X	X	6.52
Ernie's Walk Expansion	Los Angeles	X	X		1.36
Glendale Narrows Riverwalk (3 phases)	Glendale & Los Angeles	X	X	X	2.16
Marsh Street Park (now Lewis MacAdams Park)	Los Angeles			X	1.79
North Atwater Creek Restoration	Los Angeles	X			2.96
North Valleyheart Riverwalk/ Zev Yaroslavsky LA River Greenway	Los Angeles		X		1.42
Ralph C. Dills Park Expansion	Paramount	X		X	12.20
Studio City Greenway	Los Angeles	X			3.90
Tujunga Wash Restoration	Los Angeles		X	X	16.57
Valleyheart Greenway	Los Angeles	X	X		1.84
34th St. Greenbelt**	Long Beach	N/A	N/A	N/A	8.3***
Cressa Park**	Long Beach	N/A	N/A	N/A	.63
Legion Lane**	Los Angeles	X		X	2.21
Pacoima Wash**	San Fernando	X	X	X	4.58
Undeveloped lot at Whitsett**	Los Angeles	N/A	N/A	N/A	.15

** Assessed for flora only (this study).
***Note: 34th St. Greenbelt refers to an earlier-developed portion of the larger Wrigley Greenbelt; most of this park is currently (2022) under construction and closed to the public.

2.2 Cooling Impact

In a separate analysis, we used methods from Wang et al. (2015) to calculate land surface temperature (LST) for the focal parks and surrounding area. To improve LST retrieval from Landsat 8 TIRS Band 10 we used a mono-windows algorithm, calculating three parameters: ground emissivity, atmospheric transmittance, and effective mean atmospheric temperature. We calculated atmospheric transmittance using local weather data and variables outlined by Wang et al. (2015). This method accounts for the fact that atmospheric absorption reduces thermal radiance traveling to the sensor in space. Next, we calculated the effective mean atmospheric temperature using local meteorological data with this equation:

$$T_a = \frac{1}{w}\int_0^w T_z dw(z, Z)$$

where w is total water vapor content from the ground to the altitude of the sensor (Z), the atmospheric temperature at z is represented by T_z, and the water vapor content between z and Z is captured by $w(z,Z)$ (Wang et al., 2015; Qin et al., 2001; Sobrino et al., 1991). To calculate ground emissivity, we calculated aster emissivity of bands 13 and 14 to correspond with Landsat 8 band 10 spectral range. Then we calculated the brightness temperature by transforming DN values into thermal radiance and converting the radiance to brightness temperature using the Planck radiance function. Finally, we were able to calculate LST and convert those values to Celsius. All analyses were conducted in Google Earth Engine (Gorelick et al., 2017). For a full list of the equations used and their explanations we refer to methods used by Wang et al. (2015).

To calculate the Normalized Difference Vegetation Index (NDVI) to understand the presence and continuity of vegetation in and around each park, we acquired Landsat 8 Collection 1 Tier 1 data, then selected and created variables for the Near Infrared (NIR) band and the Red band in Google Earth Engine. We used the following expression to calculate NDVI: (NIR-RED)/(NIR+RED) (Landsat Normalized Difference Vegetation Index | U.S. Geological Survey, 2022). This produced NDVI values ranging from -1 to +1, corresponding to areas of trees, lawn and lush landscaping (green), residential housing (yellow), paved roads and concrete river channel (brown), and open water (white) (**Figures S1-3**).

We used methods from Cheng et al. (2014, 2017) and from Wu et al. (2021) to calculate "cooling effect". Estimating the cooling effect of green space is based on the "local cool island intensity" concept introduced by Chang et al. (2007), essentially the difference between the temperature of the park and that of its surrounding area. We selected two cooling indicators to assess the cooling effect of the parks: Maximum Local Cool Island Intensity (MLCII) and Maximum Cooling Distance (MCD). MLCII is a measure of the cooling impact of the park, while MCD indicates the largest distance that MLCII reaches for a particular park. To quantify MCLII we used the following equation: MLCII = T_s-T_p (Cheng et al. 2014; Wu et al. 2021). T_s is the maximum mean LST of the surrounding area and T_p is the mean LST within the pocket park. To calculate these indicators, we created a series of 10-meter-wide buffer increments up to 500 meters in distance around each pocket park using the multiple ring buffer tool in ArcGIS Pro (ArcGIS Pro 2.9.2, 2022; Cheng et al. 2014). We used the zonal statistics tool in ArcGIS Pro to derive the mean LST for each pocket park and each of its surrounding buffer rings.

To ensure there were no overlapping buffer rings which would influence the MLCII for each park, we aggregated parks located within 1000 meters of one another into discrete "sites", and excluded parks that were unfinished or which lacked public access (see **Appendix Table S1b** for list of sites used in the cooling impact analysis). In addition, we calculated the percentage of impervious land cover, pervious land cover, and water cover inside the parks and within the buffers surrounding the parks to understand other contributing factors to cooling within the area. We used the National Land Cover 2019 dataset, which has 20 land classes and

30-meter resolution (Dewitz et al., 2021). This dataset was selected to match the 30-meter resolution of the land surface temperature analysis. A limitation of using 30-meter resolution land cover data in an urban area is that heterogeneity of land cover is often lost in the analysis, particularly in smaller areas such as a park. NLCD attempts to address this with four levels of developed land cover classes, which acknowledges a mix of impervious land cover and pervious land cover. For the purposes of this analysis, we aggregated all the pervious land cover classes, including the "Developed, Open Space" land cover class, as this is mostly pervious cover, into one class. We then aggerated the remaining three developed land classes into one impervious class and kept the "Open Water" class to capture the influence of the river on cooling in the area.

Finally, we conducted a Pearson correlation analysis to measure the influence of cooling between the parks and the surrounding landscape as well as the association of land cover within the parks and the mean land surface temperature of the park. Before this analysis was conducted, each variable was tested for normality using the Shapiro-Wilk test. If a variable did not follow a normal distribution, we used a logarithmic transformation to satisfy the normal distribution requirement for the Pearson correlation test. This analysis was conducted in R Studio.

2.3 Park Flora, Features, and Indicator Species

To assess floristic richness, we visited each accessible pocket park in late 2021 and early 2022, taking notes on all plant species used in the landscaping, and separating each species/taxon into four categories by presumed origin:

- Naturally-occurring native;
- Planted/locally-native;
- Planted/not locally-native; and
- Non-native (to California).

We observed a handful of obvious cultivars of locally-native plants, which we lumped with wild-type individuals in our surveys. We observed, but did not record, ubiquitous, non-planted, non-native weeds (e.g., common sow-thistle *Sonchus oleraceus*), since they provide relatively little specific information on the history or ecology of each park. We list all plant taxa observed in **Appendix Table S2a.**

During these site visits, we also recorded the presence of other environmental features at each pocket park, including adjacency to a vegetated river channel vs. a concrete-lined one (see **Figure 3**), and "bio-available water", which we defined as standing or flowing water during spring 2022. We list these in **Appendix Table S2b.**

Figure 3. (Left) Natural, vegetated portion of the Los Angeles River, adjacent to North Atwater Park. This site had recently been subject to giant cane (*Arundo donax*) removal treatment, which eliminated much of the (non-native) understory vegetation. Water pooling along the concrete apron (foreground) occurs not from flooding, but from artesian wells located throughout the length of the river, particularly in the Elysian Valley. (Right) Tujunga Greenbelt in Van Nuys neighborhood of the San Fernando Valley, showing abrupt contrast between vegetation in pocket park and the concretized "box channel" entirely devoid of vegetation. Until recently, this site had been essentially bare dirt; today, the back fences of adjacent houses are completely obscured by (native) landscaping. Photos: Nurit D. Katz.

To compare wildlife richness among focal parks, and between the parks and the surrounding neighborhoods, we identified 15 "riparian indicator species" **(Appendix Table S3)** on the basis of their being 1) readily observable and identifiable and therefore frequently uploaded to community-science platforms, and 2) representing a range of river-associated habitat preferences, being found in either emergent wetland, willow riparian woodland, sandy river wash, and related habitat types (see Siddig et al. 2015). We downloaded confirmed, geo-referenced sightings of each of these 15 species from the Global Biodiversity Information Center (GBIF) from Los Angeles County within dates spanning Jan. 1, 2016 to September 5, 2022, then used QGIS 3.22.8 to calculate indicator species richness within each focal park and from a 500-meter buffer surrounding each park (GBIF 2022). We then confirmed these visually using the mapping tool in iNaturalist (www.inaturalist.org) to ensure we were accurately capturing records.

To examine avian species richness at the parks, we used the community-science platform eBird (www.ebird.org) to calculate the number of bird species recorded at each park using the named "Hotspot" (if it explicitly included the park; eBird Hotspots are simply mapped locations that observers can link to checklists, enabling quick location-based data analysis). Lastly, we compiled a metric of observer visitation of each pocket park by assuming birder visitation was similar to visitation by other nature-observers, and tallied the total number of complete checklists submitted to eBird for the relevant "Hotspot".

We analyzed the relationships between species richness, park visitation and various environmental factors (see **Appendix Table S2b**) with a Spearman's Rank correlation test using the *ggcorr* function in the *GGally* package (version 2.1.2) in R (R Studio Version 1.3.1093).

Figure 4. Song sparrow (*Melospiza melodia*), singing at Tujunga Greenbelt (which had a single eBird checklist submitted as of 16 March 2022, vs. several hundred from other parks examined). Song sparrow was one of 15 riparian indicator species used to compare biodiversity levels of the parks.

3 RESULTS

3.1 Cooling Impact

We examined cooling in four ways, including NDVI (vegetation presence), LST (land surface temperature), MLCII (local cool island intensity), and MCD (maximum cooling distance impact of each park), and present the results in **Appendix Table S4**. Looking at the parks and their buffers (to 500 m), we observed NDVI values of a range from +1.0 to -1.0, which correspond to areas of barren sand and open water (c. 0.1), sparse vegetation and built areas (0.2 to 0.5), to highly-vegetated areas (0.6 to 0.9); these may be seen in **Figures S1-3**. The NDVI values of the parks themselves ranged from 0.15 to 0.36 (mean = 0.24; **Appendix Table S5**), indicating (correctly) that these parks feature a mix of sparse vegetation and barren soil or hardscape, lacking the lush vegetation of certain areas of river channel or of certain surrounding residential neighborhoods. Of the sites examined, we found that Lewis MacAdams Riverfront Park, located in the Elysian Valley, had the highest NDVI value, while the (unfinished) River Shore View Trail, located in Long Beach (essentially a coastal jetty comprised of riprap, sand and gravel), had the lowest. We note that Lewis MacAdams Riverfront Park has large grass-covered sections as well as mature trees throughout the park, which likely contribute to a high NDVI value.

The mean land surface temperature (LST) of the parks ranged from 27.51 degrees Celsius to 47.41 degrees Celsius (mean = 42.01 degrees Celsius). Visually, areas with the highest calculated temperatures are shown as red, with the coolest areas in blue (**Appendix Figures S4-5 and Figure 5**). We found the West Valley Los Angeles River Greenway/Bikeway park (unfinished) to have the highest mean LST, while the River Shore View Trail park (also unfinished) had the lowest **(Figure 5);** however, its location on a large, deep tidal inlet of the Los

Angeles River, adjacent to the Golden Shore Marine Reserve are likely factors in its cooling capacity (rather than an inherent quality of the narrow "park" itself). By contrast, the West Valley Los Angeles Greenway/Bikeway park is a narrow strip (even for a linear park) along a channelized/concrete-floor portion of the river, surrounded by dense residential development, and would be expected to have an elevated temperature relative to its setting.

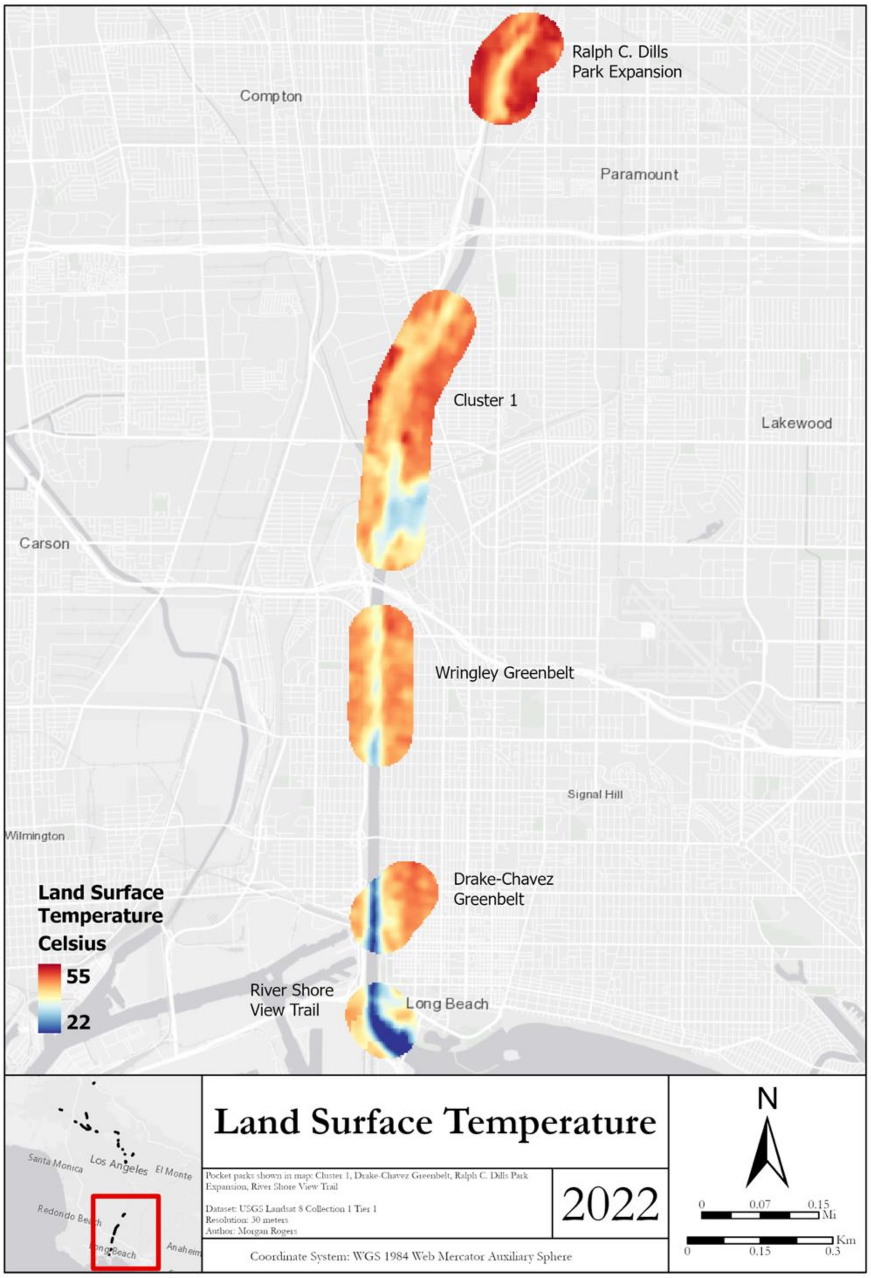


Figure 5. Land surface temperature analysis of Ralph C. Dills Park Expansion, Cluster 1, Wringely Greenbelt, Drake-Chavez Greenbelt, and River Shore View Trail

The cooling effect of these parks can extend outward to 500 meters, but on average, we found that it reaches to approximately 344 meters (**Appendix Table S5**).We calculated the average cooling effect of the parks (relative to the surrounding area) to be 3.3 degrees Celsius, with the River Shore View Trail (again, likely owing to the adjacent deep-water channel) having the greatest cooling effect, at 11.38 degrees Celsius, as well as the greatest maximum cooling distance (MCD) (**Appendix Table S4**). Both Tujunga Wash and North Atwater Park had the lowest MCD, but still contributed cooling to the area, with Tujunga Wash contributing 2 degrees Celsius cooling and North Atwater Park 3.9 degrees Celsius. The lowest-performing pocket park in terms of local cooling island intensity (MLCII) was again the West Valley Los Angeles River Greenway/Bikeway, likely due to the fact that it is a narrow strip park on a fully-paved portion of the river channel (and has not yet been landscaped).

We analyzed the relationship between the cooling indicators and land cover, both inside the park and in the surrounding 500-meter buffer area, and only found two significant associations. There were no significant relationships between pervious land and impervious land inside the parks and cooling indicators. (**Appendix Table S6**). We found a significant negative association between presence of pervious land in the surrounding buffer area and maximum local cool island intensity. While this result was unexpected, it is not entirely surprising given the coarse resolution of the land cover data, which does not capture trees, bushes, and lawns in residential areas. By contrast, we found a significant positive relationship between the presence of water and the maximum local cool island intensity **(Appendix Table S7)**. This result was expected given that water provides cooling benefits, and the river is large enough to be captured in 30-meter resolution imagery. These results suggest that the cooling effect of the parks can either be increased or decreased depending on the surrounding landcover.

3.2 Ecological Indicators

3.2.1 Floral Diversity and Origin

Of 151 plant species we recorded during our plant surveys of 18 parks, fewer than half (n=60, or c. 40% of the total palette) were identified as being locally native, i.e., to the Los Angeles Basin floor. Locally-native (planted) species richness varied from just four (at Studio City Greenway) to 28 at DeForest Park (mean = 13.8 taxa). We noted 19 native species in parks sampled that appear to be naturally-occurring, in that 1) they are absent or scarce in the native plant nursery trade, 2) rarely used in common seed mixes, 3) are frequently wind-dispersed, and 4) were generally observed in un-cultivated areas of the focal park (or future park site). Examples include cliff-aster (*Malacothrix saxatilis*) and everlastings (*Pseudognaphalium* spp.). We identified 31 species as “not locally-native”, meaning they may occur within the political border of California, but not in the Los Angeles Basin except where introduced (e.g., knobcone pine *Pinus attenuata*). Finally, we identified 39 taxa not native to California planted within parks (e.g., Peruvian pepper *Schinus molle*); some of these may have been present prior to the recent installation of landscaping under AB 1147, and some may have volunteered from plantings nearby, or dispersed by birds or wind, etc. See **Appendix Table S2a** for a complete list of plant species identified, and their representation in the parks sampled.

This breakdown may be compared to findings from a recent flora of the Los Angeles River channel (Cooper 2022), in that just 55 of 151 total species observed at parks are shared with the 282 taxa recently inventoried along the Los Angeles River channel (c. 36%), and even fewer planted native species in the parks were also recorded along the Los Angeles River channel (n=18).

The number of native-to-California (including those found in the state, but not locally-native) species planted at each pocket park evaluated ranged from 1-13 (mean = 8 taxa). While there were more local natives planted, on average, this ratio varied by park, with two parks having been planted with *more* non-natives than local natives (Studio City Greenway, Valleyheart Greenway) (**Appendix Table S2b**). However, we did not quantify percent cover by native category (only species richness), and several parks had been landscaped such that the percent cover by local Los Angeles Basin natives, appeared (visually) to be over 90%, including Atwater West and Tujunga Greenbelt.

3.2.2 Faunal Richness

We found an average of 2.5 indicator species of wildlife recorded within each of the 15 linear parks analyzed (range 0-9), and 4.7 species in the surrounding buffer (range 0-11). While the number of indicator species in the surrounding buffer zone (exclusive of the park) typically exceeded that of the linear park itself, this pattern was reversed at a handful of sites, suggesting that the parks are contributing importantly to the presence of native riparian species in the neighborhood (**Table 2**). These sites include Dominguez Gap Wetlands, which had nearly double the number of indicator species than have been recorded elsewhere in the surrounding census tract, which is comprised largely of dense residential development and a private golf course. Valleyheart Greenway and Tujunga Greenway, both planted strips atop a cement box channels through the residential (and densely-developed) San Fernando Valley, also had more indicator species than the surrounding buffer area. This illustrates the ability of these parks to serve as “islands” of native biodiversity in their respective neighborhoods.

Table 2. Biodiversity Data for each pocket park. Each park site has been identified as an eBird "hotspot" except for Albion/Downey Recreation Center and Drake-Chavez Greenbelt.

Park Name	Indicator Species Richness (parks)	Indicator Species Richness (500m Buffers)	eBird species	eBird checklists submitted
Albion/Downey Recreation Center	**0**	**2**	**N/A**	**N/A**
Anza Trail/ Weddington Golf Course Edge	**4**	**3**	**70**	**39**
Atwater Village West River Park	**0**	**6**	**140**	**195**
DeForest Wetland Restoration	**7**	**9**	**123**	**212**
Dominguez Gap Wetlands	**9**	**5**	**163**	**255**
Drake-Chavez Greenbelt	**0**	**5**	**na**	**na**
Ernie's Walk Expansion	**0**	**1**	**28**	**13**
Glendale Narrows Riverwalk (3 phases)	**6**	**11**	**175**	**746**
Marsh Street Park (now called Lewis MacAdams Park)	**4**	**8**	**98**	**80**
North Atwater Creek Restoration	**3**	**10**	**154**	**279**
North Valleyheart Riverwalk/ Zev Yaroslavsky LA River Greenway	**0**	**2**	**78**	**129**
Ralph C. Dills Park Expansion	**1**	**4**	**141**	**207**
Studio City Greenway	**1**	**3**	**33**	**8**
Tujunga Wash Restoration	**1**	**0**	**15**	**1**
Valleyheart Greenway	**2**	**1**	**47**	**19**

Ten of the 32 linear parks evaluated were also eBird Hotspots, and an additional 13 parks are located within larger eBird Hotspots. Complete eBird checklists submitted (through 16 March 2022) from mapped Hotspots averaged c. 200 checklists/Hotspot (min. = 1; Tujunga Wash Greenway; max. = 255; Dominguez Gap Wetlands). The number of bird species reported from each park Hotspot averaged 102 (min. = 28, max. = 200).

3.2.3 Bio-available Water and In-channel Vegetation

Despite its high importance for wildlife, in particular riparian and wetland species in arid areas, just four of completed pocket park projects (25%) featured bio-available surface water, with just two (Dominguez Gap Wetlands and Deforest Park; **Figure 6**) having more than a trickle. These two sites are also notable in that they have essentially re-created river-like habitats along a stretch of the Los Angeles River channel that has been completely paved-over (north Long Beach).

Figure 6. Examples of "bio-available water" at DeForest Park (Left) and Dominguez Gap wetlands (Right). Photos by Nurit D. Katz.

3.2.4 Correlations between species richness and human/environmental variables

We found weakly positive correlations between indicator species of wildlife in the parks and two environmental variables measured, bio-available water and area (**Figure 7**). We did not find the diversity of plant species at the parks to be positively correlated to either total bird species or total indicator species, with total indicator species slightly negatively correlated with two plant species diversity variables (local native species richness, total plant species richness). However, we found a *positive* correlation between the number of indicator species recorded in the *buffers* surrounding the parks (but not in the parks themselves) and the presence of a vegetated channel (vs. bare concrete channel) adjacent to the park.

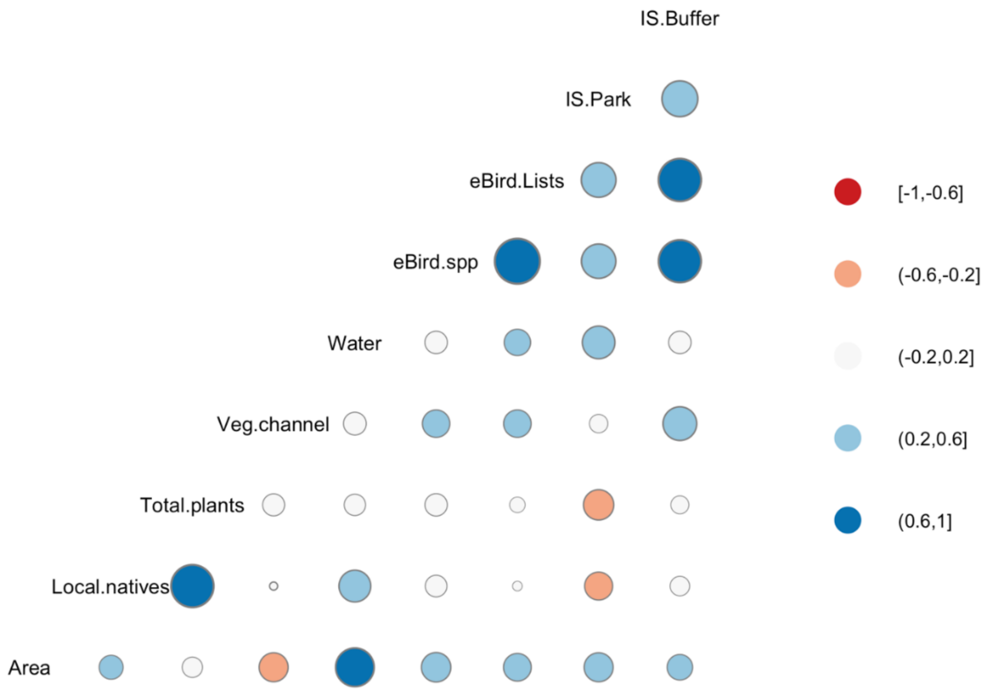


Figure 7. Correlation between indicator species, avian diversity, environmental features, and human visitation at the parks.

The presence of an adjacent vegetated (river) channel was (weakly) positively correlated with both avian species richness and visitation (as measured by number of eBird checklists submitted), as well as with the number of indicator species in the buffer surrounding the park. However, the number of indicator species within the park was not correlated with the presence of a vegetated channel.

We found strong positive correlations between the number of eBird checklists for each Hotspot and the total/cumulative number of birds observed at that Hotspot, and the number of indicator wildlife species in the park buffer.

3.2.5 Relictual Vegetation and Special-status Species

An oft-overlooked feature of several parks, and of the Los Angeles River channel edge in general, is the presence of previously-existing vegetation features such as old/relictual stands of native riparian vegetation that were apparently spared during channelization, and areas of native vegetation that have developed subsequent to channelization and disturbance. While these were not systematically searched-for and documented at each park, we observed large blue elderberry (*Sambucus caerulea*) shrubs at multiple park sites, some incorporated into the (newer) landscaping of the parks examined (**Figure 8**), providing important foraging and potentially nesting habitat for birds. At tiny Cressa Park in Long Beach, we noted large Fremont cottonwood (*Populus fremontii*) trees in the park outside the Los Angeles River channel levee (and therefore perhaps pre-dating the channelization), as well as dense stands of native alkali-weed (*Cressa truxillensis*), which presumably inspired the park’s unusual name (**Figure 9**).

Figure 8. Massive (relictual) blue elderberries incorporated into pocket park landscaping, Atwater West Park. Photos by Daniel S. Cooper.

Figure 9. Mature Fremont cottonwood (*Populus fremontii*), with alkali-weed (*Cressa truxillensis*) emerging in foreground at Cressa Park in Long Beach. Los Angeles River channel fenceline/levee is at right. Photo by Nurit D. Katz

While we did not specifically search for special-status species during our brief surveys, in 2022, we discovered an active nest of the Federally and State Endangered least Bell's vireo (*Vireo bellii pusillus*) at a small but densely-planted (with natives) pocket park (Atwater West), which may represent the first confirmed instance of nesting of this species along the LAR away from the extensive habitat at the Sepulveda Basin. Yellow Warbler (*Setophaga petechia*), a California Species of Special Concern, was found to be common at many of the parks in the Glendale Narrows/Elysian Valley, and sparingly elsewhere. Sensitive plant species we noted (planted) at the parks included the Federally Endangered Nevin's barberry (*Berberis nevinii*) at

Atwater West and 34th Ave. Greenbelt, and two other California Native Plant Society-ranked taxa, fragrant pitcher sage (*Lepechinia fragrans*) and Engelmann oak (*Quercus engelmannii*); these are naturally-occurring from the Los Angeles area, but not from the portion of the Los Angeles Basin occupied by the Los Angeles River (Calflora 2022). Other sensitive plant species we noted as planted at the parks are from ever farther-flung regions of the state, including San Diego marsh elder (*Iva hayesiana*), native to the extreme southwestern corner of the state; tree anemone (*Carpenteria californica*), native to a small area of the central Sierra Nevada foothills; and Santa Catalina Island currant (*Ribes viburnifolium*), native to that island.

4 DISCUSSION AND RECOMMENDATIONS

4.1 Cooling Impacts

Given continued warming temperatures, particularly in Mediterranean climates (Cutter et al. 2017), small greenspaces may become critical to providing shade and local relief for urban residents during summer and fall. All of the sampled parks appear to be acting as “cool islands”, effectively lowering the surrounding urban LST; however, cooling effects are either attenuated or strengthened depending on the composition of surrounding land cover, confirming previous studies (Wu et al., 2021). This study supports prior research suggesting that linear parks can help ameliorate hot urban environments (see Change et al, 2007; Cheng et al, 2014; Zhou et al., 2017; Xiao et al., 2018; Carlan et al., 2020, Wu et al., 2021). This is especially important for highly urbanized areas along concretized river channel sections that have little vegetation. Many of these sites are located in neighborhoods with relatively few parks. For example, at Ralph Dills Park in Paramount, we saw the greatest “cool island” effect relative to the surrounding dense residential neighborhood, characterized by densely-packed houses on small lots (**Table S4**). In these cases, small, linear parks are highly valuable both in providing both crucial access to green space *and* cooling services. An important next step in this research would be to obtain finer-scale climate data in order to get a more detailed understanding of contributing factors to cooling effects both inside and outside the park. While land surface temperature data is helpful for assessing the mitigation of urban heat island effect, it does not capture microclimate conditions that impact thermal comfort of pedestrians (Rosso et al., 2022, Turner et al, 2022). Moreover, this line of inquiry could provide insight into ways to optimize parks to realize their maximum cooling potential.

4.2 Role of linear parks in biodiversity conservation

The low percentage of locally-native plants found in the linear parks, and the low percentage of these that are also found in the (adjacent) Los Angeles River, is concerning given the long availability of excellent guidelines on using natives to recreate the habitats once present in the lower watershed of the Los Angeles River (LADPW 2004). The finding of a positive correlation between the number of indicator species (and bird species) recorded in the buffers surrounding the parks (but not in the parks themselves) and the presence of a vegetated channel (vs. bare concrete channel) adjacent to the park suggest that their local occurrence may owe more to the habitat in the surrounding landscape than that within the parks themselves. Indeed, small parks near vegetated channels or “woodsy” residential areas may themselves have *lower* species richness than the surrounding area, while others in more highly-urbanized neighborhoods that represent some of the best wildlife habitat in the area (e.g., Dominguez Gap Wetlands, near

Carson), including some of the highest counts of indicator species we found. And while we were not specifically looking for rare and special-status species, the discovery of a least Bell's vireo using one of the most anthropogenically-disturbed parks was a delightful surprise. Unfortunately, this nest failed by early June (2022), likely due to anthropogenic disturbance as evidenced by the nest substrate and the surrounding vegetation being trampled. This illustrates the management challenges inherent to all urban parks.

The positive correlations found among the number of eBird checklists for each park Hotspot, the total number of birds observed at that Hotspot (over time), the indicator species in the park buffer, and the presence of vegetated channel may simply suggest that nature-observers (including birders) prefer to visit parks that are located in areas with high species richness, regardless of the presence of native (or non-native) plants. This also supports decisions to develop new parks (including small and linear parks) in areas with little existing habitat in order to open new opportunities for visitors, including local residents.

We note an important caveat with the community science data used, in that the determination of a given indicator species using each park was complicated by unavoidable weaknesses of many community-science platforms, in particular the way birds and far-off subjects are recorded. As noted in the Results section, because the parks are linear features, and since most of them are directly adjacent to much more popular birding/natural-habitat locations (i.e., vegetated stretches of the Los Angeles River channel), the distinction between a given observation having been obtained *inside* the pocket park, versus seen *from* the pocket park (and potentially along the river channel), could not be made by us. In reviewing records in iNaturalist, we observed that if a park is too small/narrow, and located atop the levee (e.g., Glendale Riverwalk), it likely inflated the count of indicator species/eBird records in that park, as observers could have stood in the pocket park and counted species that were actually located in the (vegetated) LAR channel and not in the park itself. Or, in cases where a park is basically a sump where observers might stand atop a levee and look down into the park (e.g., Atwater North), species may be *undercounted* in the park for the same reason – the observers were not standing inside the park boundaries, muddling the actual locations of the observations. Still, these would likely simply distribute "noise" throughout the dataset, and we would not expect our findings to be contradicted by more accurate boundary delineation.

4.3 Management Recommendations

Since linear parks landscaped with natives are so different from the traditional urban park in southern California and the Southwest, what may be perceived by park managers as "weeds" can often be naturally-occurring native vegetation with considerable habitat value. Over-manicuring these parks, in addition to being costly, can also reduce habitat, which may be the only native vegetation for miles around. Maintenance activities, such as leaf blowing, can eliminate leaf litter in planted areas that provide rare habitat for invertebrates that are a food source for native species. Encouragingly, at Hollydale Park in South Gate, deep into the urbanized floor of the Los Angeles Basin, leaf litter was allowed to remain in native planted areas, and during our brief survey we observed California Towhee (*Melozone crissalis*) and Audubon's cottontail (*Sylvalagus audubonii*) utilizing these patches despite their being largely absent from the surrounding densely-urbanized neighborhoods (**Figure 10**). Towhees were also observed foraging at Ralph Dills Park prior to litter removal, but on a follow-up visit here, we documented aggressive maintenance (including "topiary"-like pruning of native shrubs) which eliminated the abundant leaf litter we had observed during our initial visit a few months earlier (**Figure 11**). To the extent that reducing this type of maintenance leads to a perception of neglect or reduced aesthetics, we recommend signage to educate park patrons on the value of weeds and leaf litter to native fauna, including pollinators.

Figure 10. California Towhee foraging in the leaf litter beneath California wild rose (*Rosa californica*) at Ralph Dills Park prior to maintenance. Photo by Nurit D. Katz.

Figure 11. (Left) Ralph Dills Park before leaf litter removal. (January 9, 2022) Photo by Nurit D. Katz. (Right) Ralph Dills Park after maintenance. (April 3, 2022) Almost unrecognizable are California sagebrush (*Artemisia californica*), in foreground, and California buckwheat (*Eriogonum fasciculatum*), in background. Photo by Daniel S. Cooper.

We observed over and over that "less is sometimes more" when it comes to vegetation maintenance at parks. While some sites we studied clearly took barren, vacant lots and brought them to life with the introduction of thousands of native plants, other areas along the river currently have native relict vegetation (notably blue elderberry) and a substantial native seed bank, and we would encourage park designers and managers to acknowledge these important resources. One site in particular, an undeveloped lot at the southwestern corner of Whitsett Ave. and the Los Angeles River (**Figure 12**), was found to support several naturally-occurring native plants, including coast morning-glory (*Calystegia macrostegia*), arroyo lupine (*Lupinus succulentus*) and two species of everlasting (*Pseudognaphalium* spp.), all of which could be incorporated into future pocket park design here, as was done well at Cressa Park in Long Beach, and Atwater West Park.

Figure 12. An example of a "weedy"/less-maintained area along the LAR channel hosts native, naturally-occurring/"volunteer" plants including this arroyo lupine (*Lupinus succulentus*), which we have never seen (deliberately) incorporated into "native plantings". Photos by Nurit D. Katz.

We hope our documentation of these linear parks encourages further research on usage of these areas by wildlife, and a deeper understanding of their role in the urban ecosystem. Despite their diminutive size, our analyses demonstrate the importance of these parks for habitat, human access to nature and cooling in an increasingly hot climate, and we hope our work inspires a deeper appreciation of these unique urban islands.

5 APPENDIX

Table S1a. 31 Los Angeles River Linear Parks (and one adjacent lot at bottom of table) surveyed in study.

**Developed and accessible parks that were assessed for biodiversity and flora (this study)
*Assessed for flora only (this study)

Park Name	**City**	**AB1147 Habitat Restoration**	**AB1147 Recreation**	**AB1147 Parkland**	**Area (acres)**
Albion/Downey Rec Center*	Los Angeles		X	X	8.814
Anza Trail/Weddington Golf Course Edge (pre-1147) **	Los Angeles	N/A	N/A	N/A	1.3807
Atwater Village West River Park**	Los Angeles		X		4.9133
Cornfields Adjacent River Park	Los Angeles		X	X	0.9134
Cressa Park (pre-1147) *	Long Beach	N/A	N/A	N/A	.63
DeForest Wetland Restoration**	Long Beach	X	X	X	31.4321
Dominguez Gap Wetlands**	Long Beach	X	X	X	34.3283
Doris Place	Los Angeles		X	X	0.2173
Drake-Chavez Greenbelt**	Long Beach	X	X	X	6.5232
E. Valley LAR Greenway/Bikeway (incl. south side LAR)	Los Angeles	X	X	X	4.9499
Ernie's Walk Expansion (LAR @ Kester) **	Department of Public Works	X	X		1.3604
Glendale Narrows Riverwalk (3 phases)**	Glendale & Los Angeles	X	X	X	2.1618
Legion Lane Park (south of Los Feliz, east side of LAR)*	Los Angeles	X		X	2.2078
Lower Tujunga Wash Greenway/Bikeway (tributary)	Los Angeles	X	X		4.9796
Marsh Street Park (now called Lewis MacAdams Park)**	Los Angeles			X	1.7872
Montecito Heights	Los Angeles			X	2.5763
Moorpark Park	Los Angeles	X	X	X	1.592
North Atwater Creek Restoration**	Los Angeles	X			2.9628
North Branch Creek Daylighting, Sycamore Grove Park	Los Angeles		X	X	0.5597
North Valleyheart Riverwalk/ Zev Yaroslavsky LA River Greenway (north side of LAR)**	Los Angeles		X		1.4209
Pacoima Wash*	San Fernando	X		X	4.582
Ralph C. Dills Park Expansion**	Paramount	X		X	12.1988
River Shore View Trail	Long Beach		X	X	0.824
Studio City Greenway**	Los Angeles	X			3.9002
Sycamore Pocket Park (Laurel Cyn/Valleyheart)	Los Angeles		X		0.0993
Tujunga Wash Restoration**	Los Angeles		X	X	16.5664
Valleyheart Greenway**	Los Angeles	X	X		1.8366
W. Valley LAR Greenway/Bikeway	Los Angeles		X		1.8366
Weddington Park Expansion	Los Angeles	X		X	5.7928
Wrigley Greenbelt*	Long Beach	X	X	X	18.1366
34th St. Greenbelt (older part of Wrigley, pre-AB 1147)*	Long Beach	N/A	N/A	N/A	8.3
Undeveloped lot at Whitsett and LAR*	Los Angeles	N/A	N/A	N/A	.15

Table S1b. Parks within 1,000 meters of each other, as aggregated into clusters for cooling impact analysis.

Cluster	Linear Parks Aggregated
1	Dominguez Gap Wetlands, DeForest Wetland Restorations
2	Albion/Downey Recreation Center, Cornfields Adjacent River Park
3	North Branch Creek Daylighting Sycamore, Montecito Heights
4	Legion Lane Park, Atwater Village West River Park
5	E. Valley LAR Greenway/Bikeway, North Valleyheart Riverwalk, Anza Trail, Studio City Greenway, Valleyheart Greenway, Lower Tujunga Wash Greenway, Moorpark Park, Sycamore Pocket Park

Table S2a: Flora of Los Angeles River Linear Parks

Latin name	English name	Origin	Tally
Acacia sp.	Wattle	Non-native	3
Achillea sp.	Yarrow	Non-locally-native/cultivar	2
Acmispon glaber	Deerweed	Planted Locally Native	4
Agave sp.	Agave sp.	Non-native	1
Albutilon palmeri	Palmer's Indian mallow	Planted Not-Local CA Native	1
Alnus betulifolia	White alder	Planted Locally Native	3
Ambrosia psilostachya	Western ragweed	Naturally-occurring Native?	2
Amorpha sp.	false-indigo	Planted Locally Native	1
Arctostaphylos glauca	Bigberry manzanita	Planted Not-Local CA Native	1
Artemisia californica	California sagebrush	Planted Locally Native	8
Artemisia douglasiana	Mugwort	Planted Locally Native	4
Asclepias currasavica	Tropical milkweed	Non-native	1
Atriplex lentiformis	Quailbush	Planted Locally Native	4
Baccharis pilularis	Coyotebush	Planted Locally Native	9
Baccharis salicifolia	Mulefat	Planted Locally Native	8
Baccharis sarthroides	Desert broom	Planted Not-Local CA Native	4
Bacopa sp.	Herb-of-grace	Non-native	1
Berberis nevinii	Nevin's barberry	Planted Not-Local CA Native	1
Berberis oregonus	Oregon barberry	Planted Not-Local CA Native	2
Calliandra californica	Baja fairy duster	Planted Not-Local CA Native	1

Calystegia macrostegia	Coast morning-glory	Naturally-occurring Native	1
Camissoniopsis micrantha	miniature suncup	Naturally-occurring Native	1
Carex praegracilis	Field sedge	Planted Locally Native	1
Carex spissa	San Diego sedge	Planted Locally Native	1
Ceanothus megacarpus	Bigpod ceanothus	Planted Locally Native	1
Cenchrus setaceus	Fountain grass	Non-native	5
Cercis occidentalis	Western redbud	Planted Not-Local CA Native	3
Chilopsis linearifolia	Desert willow	Planted Not-Local CA Native	1
Cinnamomum camphora	Camphor laurel	Non-native	1
Clarkia unguiculata	Elegant clarkia (cultivar)	Planted Locally Native-cultivar	1
Cleome isomeris	Bladder-pod	Planted Locally Native	3
Cortaderia selloana	Pampas grass	Non-native	1
Cressa truxillensis	Alkali-weed	Naturally-occurring Native Native(Cressa Park)	1
Cupaniopsis anacardioides	Carrotwood	Non-native	2
Cylindropuntia californica	California cholla	Planted Locally Native	1
Cyperus esculentus	Tall flatsedge	Naturally-occurring Native	1
Datura wrightii	Sacred datura	Naturally-occurring Native	2
Diplacus longifolius	Sticky monkeyflower	Planted Locally Native	2
Eclipta prostrata	Eclipta	Naturally-occurring Native	1
Encelia californica	California sunflower	Planted Locally Native	11
Epilobium canum	California fuchsia	Planted Locally Native	2
Eriogonum fasciculatum	California buckwheat	Planted Locally Native	9
Eriophyllum confertifolium	Golden yarrow	Planted Locally Native	1
Erythrostemon mexicanus	Mexican holdback	Non-native	2
Eschscholzia californica	California poppy	Planted Locally Native	2
Eucalyptus sp.	Eucalyptus	Non-native	1
Frangula californica	Coffeeberry	Planted Locally Native	2
Fraxinus uhdei	Shamel ash	Non-native	3
Gambelia speciosa	Island bush snapdragon	Planted Not-Local CA Native	2
Gleditsia triacanthos	Honey locust	Non-native	1
Heteromeles arbutifolia	Toyon	Planted Locally Native	9
Isocoma menziesii	Coast goldenbush	Planted Locally Native	6
Iva hayesiana	San Diego marsh-elder	Planted Not-Local CA Native	3
Juglans californica	Southern California black walnut	Planted Locally Native	2
Juncus cf. balticus	Rush	Planted Locally Native	3
Kniphofia	Red hot poker	Non-native	0
Koelreutania sp.	Golden rain tree	Non-native	1
Lantana montevidensis	Trailing lantana	Non-native	2

Lavatera assurgentiflora	Island mallow	Planted Not-Local CA Native	2
Leymus condensatus	Giant wild rye	Planted Locally Native	5
Leymus glaucus	Blue wild rye	Planted Not-Local CA Native	1
Leymus triticoides	Alkali wild rye	Planted Locally Native	1
Ludwigia sp.	water primrose	Planted Locally Native	0
Lupinus longifolius	longleaf bush-lupine	Planted Locally Native	1
Lupinus succulentus	Arroyo lupine	Naturally-occurring Native	3
Lupinus truncatus	Collared lupine	Naturally-occurring Native	1
Malacothamnus cf. fasciculatus	Bush-mallow	Planted Locally Native	1
Malacothrix saxatilis	Cliffaster	Naturally-occurring Native	2
Malosma laurina	Laurel sumac	Planted Locally Native	3
Melaleuca citrina	Bottlebrush	Non-native	2
Muhlenbergia rigens	Deergrass	Planted Not-Local CA Native	4
Nerium oleander	Oleander	Non-native	1
Oenothera elata	Hooker's evening-primrose	Naturally-occurring Native	1
Opuntia littoralis	Coast prickly pear	Planted Locally Native	3
Pinus attenuata	Knobcone pine	Planted Not-Local CA Native	0
Pinus torreyana	Torrey pine	Planted Not-Local CA Native	1
Platanus racemosa	Western sycamore	Planted Locally Native	11
Pluchea sericea	Arrowweed	Planted Not-Local CA Native	4
Plumbago auriculata	Cape leadwort	Non-native	1
Populus fremontii	Fremont cottonwood	Naturally-occurring Native at Cressa Park	6
Prunus ilicifolia	Hollyleaf cherry	Planted Locally Native	6
Prunus lyonii	Island cherry	Planted Not-Local CA Native	2
Pseudognaphalium californicum	California cudweed	Naturally-occurring Native	1
Psuedognaphalium biolettii	Two-toned everlasting	Naturally-occurring Native	2
Quercus agrifolia	Coast live oak	Planted Locally Native	10
Quercus engelmannii	Engelmann oak	Planted Not-Local CA Native	1
Quercus ilex	Holm oak	Non-native	1
Quercus lobata	Valley oak	Planted Not-Local CA Native	5
Quercus suber	Cork oak	Non-native	1
Rhus integrifolia	Lemonadeberry	Planted Locally Native	4
Rhus ovata	Sugarbush	Planted Locally Native	3
Rhus x	Hybrid sumac	Planted Locally Native	1
Ribes aureum	Golden currant	Planted Locally Native	1
Ribes speciosum	Fuchsia-flowered gooseberry	Planted Locally Native	1
Romneya sp.	Matillija poppy	Planted Not-Local CA Native	2
Rosa californica	California wild rose	Planted Locally Native	9

Rubus ursinus	California blackberry	Planted Locally Native	3
Salix exigua	Narrowleaf willow	Planted Locally Native	2
Salix gooddingii	Black willow	Planted Locally Native	6
Salix lasiolepis	Arroyo willow	Planted Locally Native	3
Salvia apiana	White sage	Planted Locally Native	6
Salvia clevelandii	Cleveland sage	Planted Not-Local CA Native	4
Salvia leucophylla	Purple sage	Planted Locally Native	4
Salvia mellifera	Black sage	Planted Locally Native	9
Salvia spathacea	Hummingbird sage	Planted Not-Local CA Native	2
Sambucus caerulea	Blue elder	Planted Locally Native	7
Schinus molle	Peruvian pepper	Non-native	1
Schoenoplectus californicus	California bullrush	Naturally-occurring Native	2
Searsia lancea	African sumac	Non-native	1
Sisyrinchium bellum	Blue-eyed grass	Planted Locally Native	1
Solanum americanum	American white nightshade	Naturally-occurring Native	1
Stipa milliaceum	Smilo grass	Non-native	2
Tagetes lemmonii	Mountain marigold	Non-native	1
Tamarix sp.	Tamarisk	Non-native	1
Ulmus parvifolius	Chinese elm	Non-native	2
Umbellularia californica	California bay	Planted Locally Native	2
Verbena lilacina "de la mina"	Verbena cultivar	Non-native	2
Vitis girdiana	Desert wild grape	Planted Locally Native	1
Washingtonia sp.	Fan palm	Non-native	3

Table S2b: Environmental Indicators and floral species richness.

Key: Flora Categories

1. Planted Locally Native Species
2. Planted Non-native Species
3. Planted Non-Local CA Native Species
4. Naturally Occurring Native Species
5. Unknown Origin Species
6. Total Locally Native Species (Planted and Naturally Occurring)
7. Total Species Diversity

Pocket Park Name	**Channel Type (0 = dry concrete; 1 = shorebird habitat; 2 = soft/vegetated; 4 = deep water)**	**Bio-available Water**	**Flora 1**	**Flora 2**	**Flora 3**	**Flora 4**	**Flora 5**	**Flora 6**	**Flora 7**
Albion/Downey Rec Center	0	0	14	3	6	0	0	14	23
Anza Trail/Weddington Golf Course Edge	0	0	15	1	0	2	0	17	18
Atwater Village West River Park	2	0	21	5	6	4	1	25	37
DeForest Wetland Restoration	1	1	28	9	4	6	0	34	47
Dominguez Gap Wetlands	1	1	12	3	1	3	0	15	19
Drake-Chavez Greenbelt	3	0	8	2	6	0	0	8	16
Ernie's Walk Expansion (LAR @ Kester)	0	0	19	10	3	3	1	22	35
Glendale Narrows Riverwalk (3 phases)	2	0	12	5	4	0	0	12	21
Marsh Street Park (now called Lewis MacAdams Park)	2	0	13	3	10	2	1	15	29
North Atwater Creek Restoration	2	1	20	1	3	1	0	21	25
North Valleyheart Riverwalk/ Zev Yaroslavsky LA River	0	0	22	2	4	2	1	24	31

Greenway (north side of LAR)									
Ralph C. Dills Park Expansion	0	0	18	8	3	0	0	18	29
Studio City Greenway	0	0	4	5	2	0	0	4	11
Tujunga Wash Restoration	0	1	25	3	2	4	1	29	35
Valleyheart Greenway	0	0	12	2	11	1	0	13	26
34th St. Greenbelt (older portion of Wrigley Greenbelt)	1	0	4	0	0	2	0	6	6
Cressa Park	0	0	6	0	1	0	0	6	7
Legion Lane	2	0	7	1	1	0	0	7	9
Pacoima Wash	0	0	20	2	1	3	0	23	26
Undeveloped lot at Whitsett and the LA River	0	0	1	0	0	6	0	7	7

Table S3. Riparian indicator species used for Los Angeles River linear parks.

Latin name	**Common name**	**Habitat**	**Class/group**
Anaxyrus boreas	Western toad	Shallow, ephemeral freshwater pools.	Amphibian
Pseudacris hypochondriaca	Pacific chorus frog	Freshwater wetlands, including seeps, streams, marshes, and small ponds.	Amphibian
Agelaius phoeniceus	Red-winged Blackbird	Emergent vegetation in freshwater marshes and similar habitats (breeding); a variety of habitats used in winter, including large lawns in urban areas and agricultural areas.	Bird
Melospiza melodia	Song Sparrow	A variety of scrubby, mesic habitats, including riparian scrub and freshwater marsh. Limited use in urban areas where lushly landscaped.	Bird
Geothlypis trichas	Common Yellowthroat	Emergent marsh vegetation (breeding season); more widespread in migration/winter (weedy fields, etc.)	Bird
Pipilo maculatus	Spotted Towhee	Chaparral, riparian and other dense scrub	Bird
Melospiza lincolnii	Lincoln's Sparrow	Grassy scrub, often near water.	Bird
Polioptila caerulea	Blue-gray Gnatcatcher	Native-dominated scrub, usually open and not too dense.	Bird
Limenitis lorquini	Lorquin’s Admiral	Riparian woodland dominated by willows (*Salix* spp.).	Insect
Plebejus acmon	Acmon Blue	Native-dominated scrub, usually open and not too dense.	Insect
Ischnura cervula	Pacific forktail	Standing or flowing freshwater with emergent vegetation.	Insect
Ischnura denticollis	Black-fronted forktail	Standing or flowing freshwater with emergent vegetation.	Insect
Sylvilagus audubonii	Audubon’s Cottontail	A variety of open habitats, including coastal scrub, sparse chaparral, woodland edge. Locally in suburban areas.	Mammal
Pituophis catenifer	Gopher snake	A variety of habitats, including very small silvers of open space in residential areas.	Reptile
Uta stansburiana	Side-blotched lizard	Arid scrub, often with areas of open sand and bare soil.	Reptile

Table S4. Cooling effect indicators, mean NDVI, and mean LST values for each park/park cluster (refer to Table S5 for a list of parks in each cluster).

	NDVI	Mean LST (C)	MLCII (C)	MCD (m)
Doris Place	0.21	42.87	3.39	470
Drake-Chavez Greenbelt	0.23	40.89	2.62	360
Ernie's Walk Expansion (LAR @ Kester)	0.25	43.76	2.7	480
Glendale Narrows Riverwalk	0.19	41.42	2.16	260
Marsh Street Park (now called Lewis MacAdams Park)	0.36	42.2	3.74	420
Cluster 1	0.25	39.69	4.86	490
Cluster 2	0.21	45.62	2.39	180
Cluster 3	0.19	41.81	2.74	180
Cluster 4	0.28	40.24	2.35	460
Cluster 5	0.23	43.78	1.06	150
North Atwater Creek Restoration	0.32	38.83	3.93	150
Pacoima Wash 8th Street Park	0.25	47.19	2.41	420
Ralph C. Dills Park Expansion	0.31	41.64	6.65	320
River Shore View Trail	0.15	27.51	11.38	500
Tujunga Wash Restoration	0.25	46.83	2.03	150
W. LAR Greenway	0.27	47.41	0.91	420
Weddington Park Expansion	0.18	43.60	1.53	350
Wringley Greenbelt	0.17	40.88	3.22	440

Table S5. Descriptive statistics of the 18 aggregated linear parks along the LA River

	Max	Min	Mean	SD
LST (C)	47.41	27.51	42.01	4.43
MLCII (C)	11.38	0.91	3.3	2.44
MCD (m)	500	150	344.44	131.65
NDVI	0.36	0.15	0.24	0.06

Table S6. Pearson Correlation Coefficients among cooling indicators land cover in the 18 aggregated linear parks along the LA River

Site-level metrics	MLCII	MCD	Mean LST
Percent Pervious Land Cover	0.44	-0.01	-0.07
Percent Impervious Land Cover	-0.13	0.18	-0.06

**Correlation is significant at the 0.05 level*

***Correlation is significant at the 0.01 level*

Table S7. Pearson Correlation Coefficients among cooling indicators and land cover surrounding the 18 aggregated linear parks along the LA River

Landscape-level metrics	MLCII	MCD
Percent Pervious Land Cover	**-0.02***	-0.02
Percent Impervious Land Cover	0.01	0.01
Percent Water Cover	**0.07****	0.19

**Correlation is significant at the 0.05 level*

***Correlation is significant at the 0.01 level*

Figure S1. Normalized Difference Vegetation Index analysis of W. LAR Greenway, Pacoima Wash 8th Street, Tujunga Wash Restoration, Ernie's Walk, Cluster 5, and Weddington Park Expansion

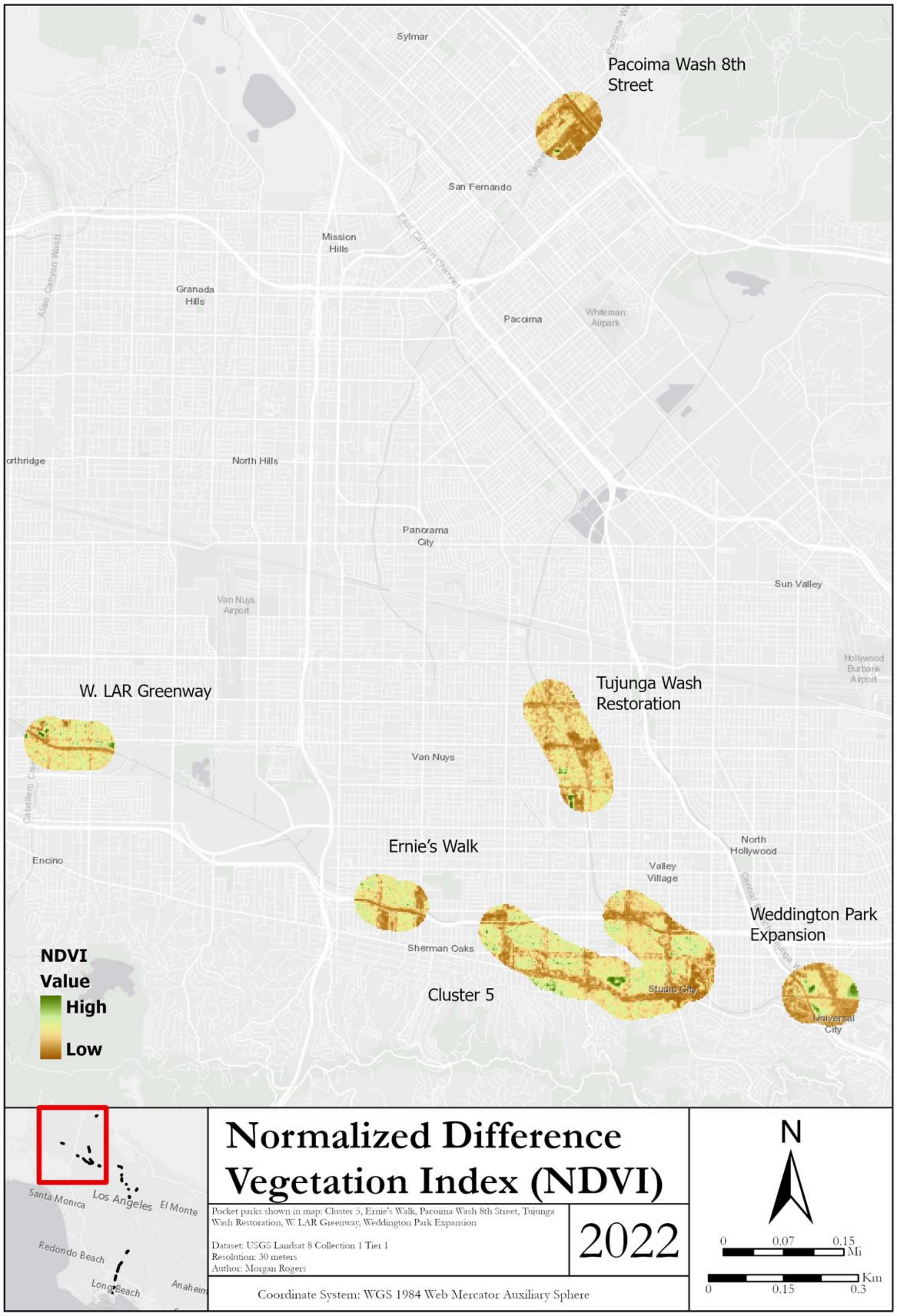


Figure S2. Normalized Difference Vegetation Index analysis of Glendale Narrows Riverwalk, North Atwater Creek Restoration, Cluster 4, Marsh Street Park, Doris Place, Cluster 2, and Cluster 3

Figure S3. Normalized Difference Vegetation Index analysis of Ralph C. Dills Park Expansion, Cluster 1, Wringely Greenbelt, Drake-Chavez Greenbelt, and River Shore View Trail

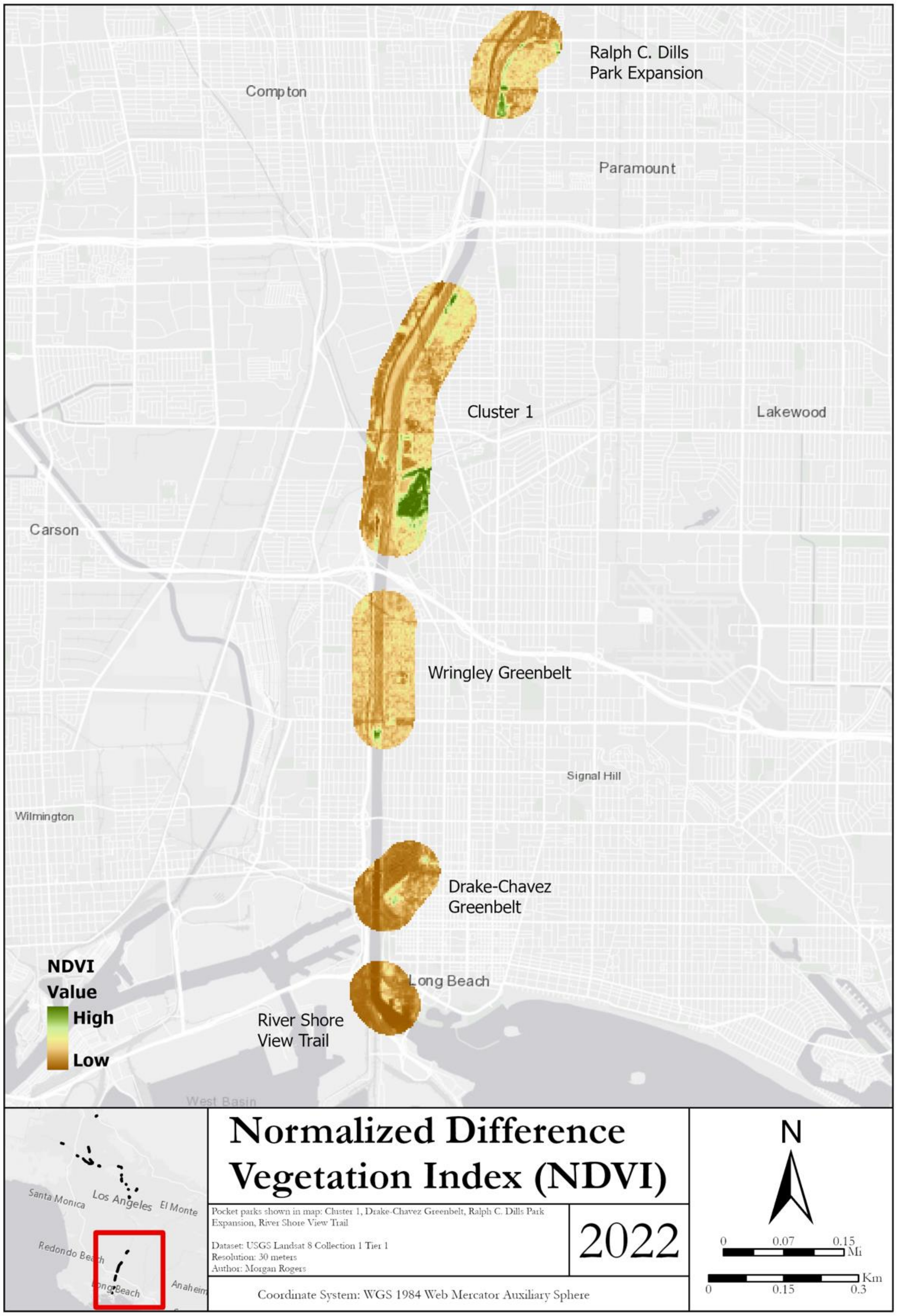


Figure S4. Land surface temperature analysis of W. LAR Greenway, Pacoima Wash 8th Street, Tujunga Wash Restoration, Ernie's Walk, Cluster 5, and Weddington Park Expansion

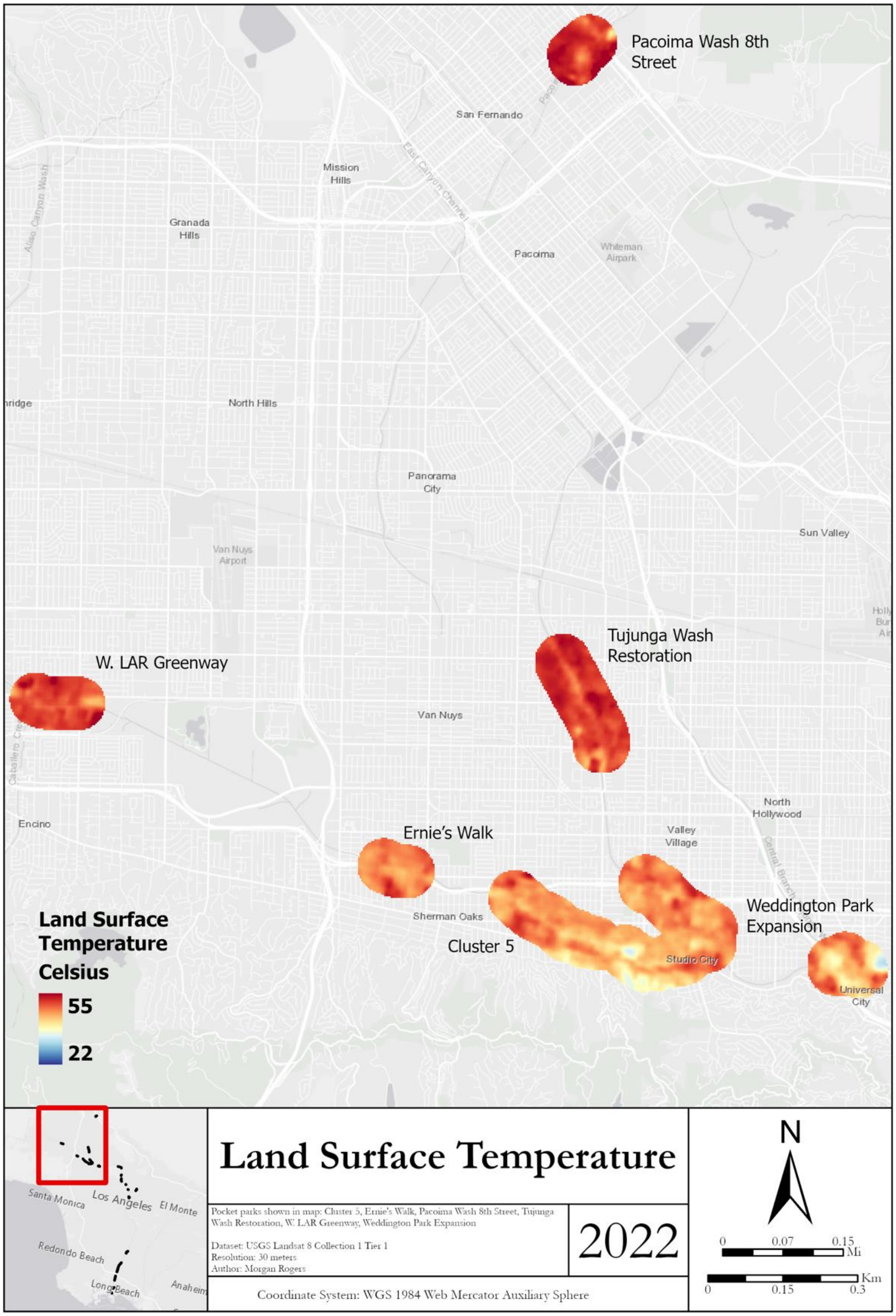
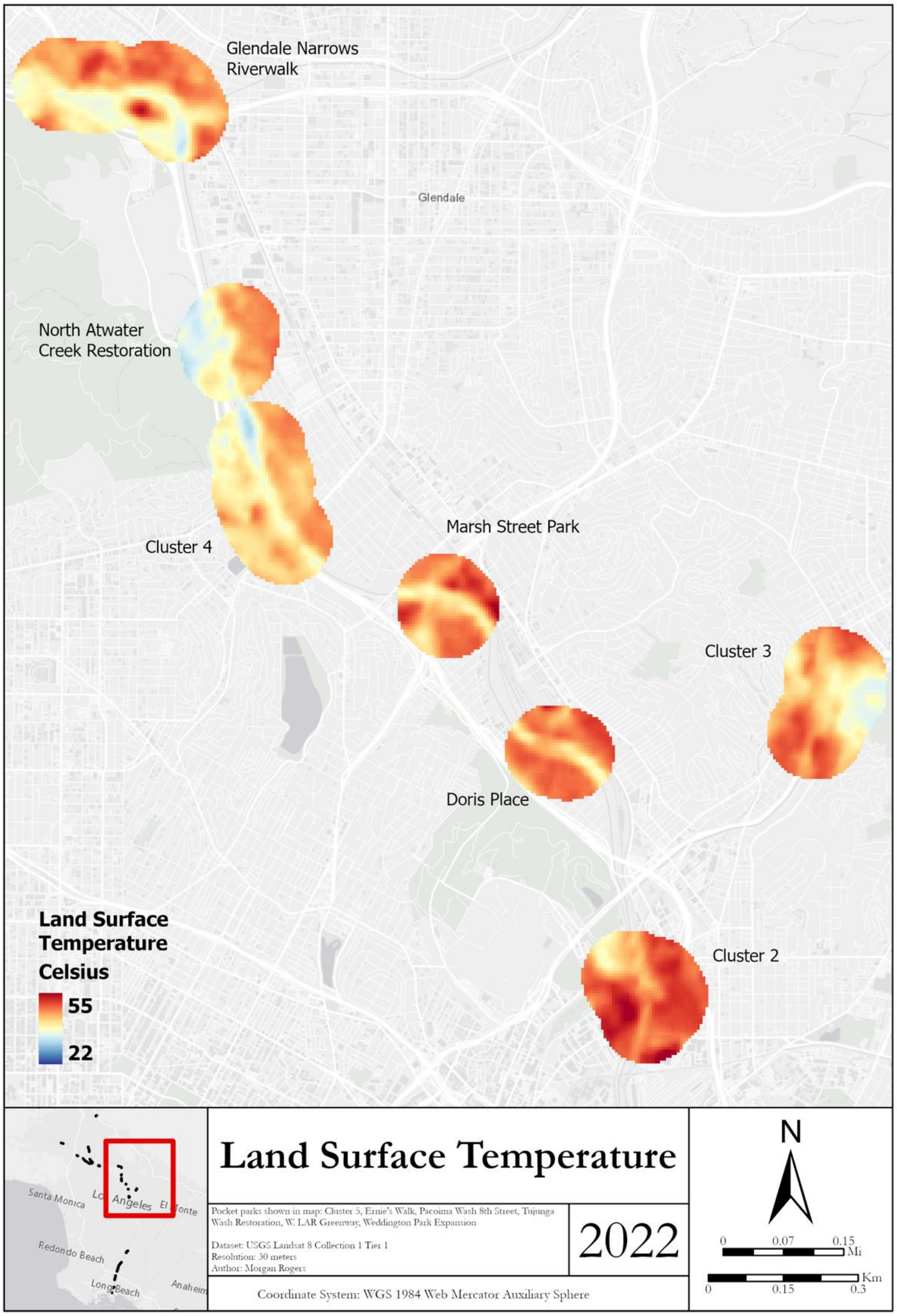


Figure S5. Land surface temperature analysis of Glendale Narrows Riverwalk, North Atwater Creek Restoration, Cluster 4, Marsh Street Park, Doris Place, Cluster 2, and Cluster 3



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