

Daylighting Parks: Sunlight Protection Policies for Urban Green Space and Their Application to Boston, Massachusetts

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Abstract

Urban parks provide essential environmental and social benefits. These benefits are especially valuable in growing cities but are increasingly threatened by shadows cast by new developments. While shade from vegetation supports ecological health and thermal comfort, building shadows block sunlight entirely, which impacts ecological health and limits park enjoyment. Although Boston, MA, contains historic parks including the Boston Common, Public Garden, and the Olmsted-designed Emerald Necklace, the city lacks a standardized and city-wide policy protecting these parks from building shadows.

This thesis examines policies to protect sunlight in parks by regulating urban development to inform policymaking in Boston. Case studies of New York City and San Francisco reveal two different and effective policy models. New York uses the City Environmental Quality Review (CEQR) process to disclose shadow impacts along with other environmental reviews, while San Francisco's Sunlight Ordinance requires shadow analyses for certain projects.

To create a sunlight protection policy for Boston's parks, this thesis recommends conducting a city-wide study of parks to understand land cover and uses, including consideration of non-vegetative sunlight-reliant resources such as historic landmarks, and setting park-specific shadow limits. Boston should include measures for shadow analysis and review within a comprehensive environmental review process and formally involve Boston's Parks and Recreation Department (BPRD) in planning and land use decisions. This will allow the city to better regulate growth and preserve sunlight access in its historic parks.

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1. Introduction

Overview

This thesis studies city policies regulating shadows from buildings on urban parks and green open space to inform policymaking for a citywide sunlight protection policy in Boston.

Urban parks provide ecosystem benefits and improve human health, and added shadow from buildings negatively impacts these green spaces and their ability to provide benefits (Villagomez 2024; Bolund and Hunhammar 1999; Tan and Ismail 2014). Currently, such development projects in Boston are reviewed and approved on a project-by-project basis and therefore proposals do not all receive the same level of scrutiny (Mauney-Brodek 2022a). A strong advocacy effort is required to ensure that each new development proposal undergoes a rigorous impact analysis and is not a threat to parks before approval. The long-term goal for the City of Boston and parks organizations is to establish a sunlight protection policy that standardizes the process by which developments with a potential to cast a shadow on urban parks are reviewed and approved, with preference given to protecting human and ecological benefits (Mauney-Brodek 2022b; City of Boston 2025e).

Urban parks and green spaces are extremely important elements in fostering a thriving community and city. They provide physical and psychological benefits to citizens as well as space for community events and easily accessible ways to engage with nature (Foderaro and Klein 2023). Additionally, trees and green space offer inherent environmental benefits by combating urban heat and acting as a natural stormwater drainage system (Taleghani 2018; Tong, McGregor, and Kinney 2021; Foderaro and Klein 2023). While tree shade within parks has a cooling benefit, added permanent shadows cast by buildings over parks can have harmful effects on both the parks and their users. New shadows lower ground temperatures, which can intensify winter conditions and increase icing and freeze/thaw cycles in ways that are unnatural for the park's plant life (Ferrick and Gatto 2005; Pincetich 2019). This makes parks which are in wetland buffers and regularly used as footpaths for walking commuters especially susceptible to erosion and dangerous icy conditions (Kaczmarek et al. 2019; Lindberg and Grimmond 2011;

Mauney-Brodek 2022b). Denser and taller development around a park also exacerbates wind and weather conditions within the park, which threatens plant life and lowers enjoyment of park use. Protecting viewscales and park designers' original intent is also important to park goers and advocates. When considering older and renowned parks such as the Emerald Necklace, Boston's largest park system, park organizations highly value the intention of designer Frederick Law Olmsted, and advocate against any development that would threaten his original designs, including tree and plant placement and sightlines into the city (Mauney-Brodek 2022b).

Research Questions

To inform policymaking efforts for sunlight protection in Boston's parks, this thesis answers the following research questions:

- I. What are the current city policies for sunlight protection in parks in the U.S.?

For each case study city:

- a) What is the purpose of the policy? Who/what is it intended to benefit?
- b) How did this policy come about? Who were the key actors in advocating for this policy?
- c) How are shadows considered in the city's project approval process?

What triggers this policy? Where is it located in terms of regulation?

Under whose jurisdiction is this policy?

- d) What does policy implementation look like?
2. What elements must be addressed to develop an effective standardized policy regulating building shadows over open/green space in Boston?

2. Background

Urban Parks in the U.S.

The notion of urban parks in America began in the 19th century to counteract the effects of industrialization. Reformers sought to bring to the city large green spaces imitating the countryside as an antidote to and respite from the overcrowded, polluted, and harried industrial life of the working class (Cranz 1982). The first urban parks were “great pleasure grounds meant to be pieces of the country, with fresh air, meadows, lakes, and sunshine right in the city” (Ibid., 5). Dubbed the father of American landscape architecture, Frederick Law Olmsted was a strong proponent of this pastoral style. Designer of 100 parks in his career in the U.S., Olmsted intended for his parks to be places of “unconscious or indirect recreation” by creating a soothing and restorative experience through the peacefulness of nature (Beveridge 2023, pg. 17). He valued a comprehensive approach that incorporated natural topography and prioritized accessibility for all people (Zaitzevsky 1982). The rapid growth of urban parks across the country between 1850 and 1900 came about largely as a response to the impending loss of breathing room as urban density, indoor work, and the intensification of business life revealed the positive qualities of the country that had been previously taken for granted (Cranz 1982). In response, Olmsted believed that parks should complement the town by creating openness that would offer tranquility and rest (Zaitzevsky 1982).

Looking past the need for parks as an alternative to the city reveals the essential connection between society and the environment; as parks scholar Araceli Masteron-Algar states, “the park is a text into the city” (Jones 2018, 41). Originally coined by Olmsted, parks are widely referred to as the “lungs of the city” (Jones 2018; Xing and Brimblecombe 2020; Crompton 2016). This line of discourse describes the city as an organism in which welfare is contingent on the circulation of human and non-human actors. Although a biological metaphor is not a scientific descriptor, it incorporates political discourse and cultural life into landscape design and contributes to explaining the transition of the park from an escape separate from the city to an “ubiquitous (and networked) part of our contemporary urban ecology” (Jones 2018, 43; Xing and Brimblecombe 2020).

Boston's Parks

Boston Common, the city and country's oldest public park (originally a 'common'), was founded in 1634 and reaffirmed as a purely public space by the City Charter in 1822 (Friends of the Public Garden n.d.). In May of 1875, the Boston City Council passed the Park Act after a long legislative process to establish a park system in the city (Zaitzevsky 1982). This established a municipal Parks Commission of three commissioners, who oversaw the acquisition of land and creation of the Emerald Necklace and the rest of Boston's parks (City of Boston 2024a). Today, the Parks Commission is part of the Parks and Recreation Department, responsible for overseeing the city's 217 parks, playgrounds, and athletic fields. Other outdoor assets that the Parks and Recreation Department manages and maintains include two golf courses, 65 squares, 17 fountains, 75 sport courts, 16 historic and three active cemeteries, and urban wilds, with approximately 125,000 trees in these spaces, and an additional 35,000 street trees. All these outdoor spaces cover 2,346 acres, 1,100 of which comprise the historic Emerald Necklace (Figure 1) (City of Boston 2024b).



Figure 1: Map of the Emerald Necklace Parks (Emerald Necklace Conservancy n.d.a.)

The Emerald Necklace, the historic crown jewel of Boston's parks, is a string of parks, greenways, and waterways stretching from the Charles River to Roxbury. The 1,100-acre park system, designed and built by Fredrick Law Olmsted between 1878 and 1896, consists of six interconnected parks – Franklin Park, Arnold Arboretum, Jamaica Pond, Olmsted Park, The Riverway, Back Bay Fens – and is attached to the pre-existing Boston Common and Public Garden via the Commonwealth Avenue Mall and Olmsted-designed Charlesgate Park (Figure 1). With an abundance of parks of varying sizes across Boston, the city's Parks and Recreation Department and other park-based organizations, including the Emerald Necklace Conservancy, Friends of the Public Garden, the Franklin Park Coalition, and Boston Harbor Now, offer many opportunities for the community to engage with the outdoors (City of Boston 2025a). A pioneer in his field, Frederick Law Olmsted's vision for Boston was to create a sense of openness through his parks that were accessible from but in contrast to the city, the benefits of which are still shared by Bostonians today.

Background: Boston's "Shadow Wars" and the Future of Planning

Boston Municipal Code Article 7 Section 4:11, the Parkways Ordinance, enacted in 1985, establishes the "100-foot rule." This rule gives jurisdiction for review to the Parks Commission for all development within 100 feet of a public park or parkway, and Section 4:10-13 places setback requirements for development near the Emerald Necklace and other parks (City of Boston 2023a). However, this buffer does not preclude parks from the range of impacts created by urban development, allowing for what architecture and urban planning columnist Renée Loth refers to as Boston's "Shadow Wars" (Loth 2023).

The origin of shadow laws in Boston stems from the Park Plaza Development proposal in 1971. The project proposed up to 600 feet of high-rise towers containing luxury apartments, shops, and a hotel along Boylston Street, abutting the southern edge of the Common and Public Garden (Kifner 1974; Martin and Rath 2024). This \$266 million urban renewal plan to redevelop what journalists at the time compared to the southern edge of Central Park, calling it "the most valuable piece of real estate in Boston," was heavily contested by the newly founded Friends of the Public Garden along with residents of the neighborhood and political

organizations across the city (Kifner 1974, pg. 17). Chairing the first Citizens Advisory Committee for the project, Henry Lee, then president of Friends of the Public Garden, fought for environmental impacts to be assessed and considered, eventually forcing the city to engage in a shadow study showing that upon completion of the project, the city would lose the sun on most of the Garden and the Common (Martin and Rath 2024). After the project was eventually denied in favor of smaller-scale development, Friends of the Public Garden continued their advocacy, leading to Boston's first shadow laws.

The Boston Common Shadow Law (1990) and Boston Public Garden Shadow Law (1993) protect the parks from future shadowing by restricting all new shadows to the first hour after sunrise (or 7:00 am, whichever is later) or the last hour before sunset (Friends of the Public Garden 2017). Within the Midtown Cultural District, abutting the parks to the east and south, a "Shadow Bank" of one acre of shadow was established from which developers are allowed to "withdraw" in excess of their shadow limit (as of 2017, <0.25 acres remained) (Figure 2) (Friends of the Public Garden 2017). In this district, the law sets specific building height limits along Tremont and Boylston Streets and authorized the Boston Redevelopment Authority (BRA) to grant exemptions (this is now the authority of the Boston Planning Department) (Friends of the Public Garden 2017). These laws are intended to protect Boston's signature public parks from excessive shadowing, while still allowing for robust downtown development, a goal that was put to the test by the Winthrop Center project proposed in 2016.

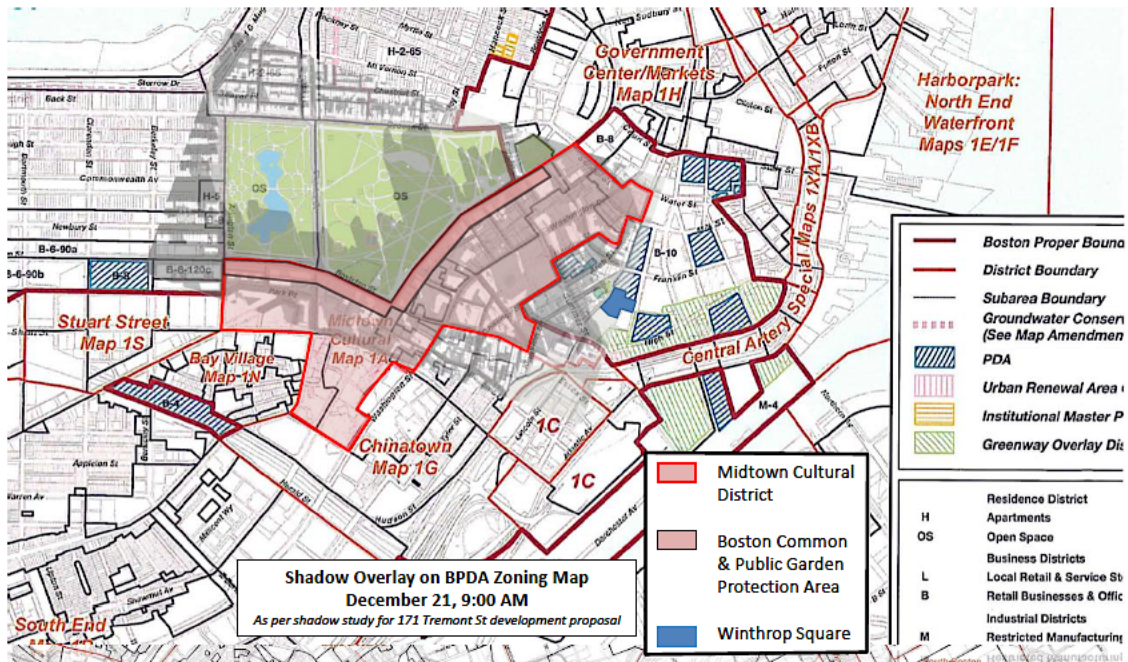


Figure 2: BPDA Zoning Map of the Boston Common and Public Garden featuring the Midtown Cultural District and Protection Area specified by the Common and Public Garden Shadow Law. Winthrop Square, the eventual site of the Winthrop Center tower, is highlighted in blue. (Friends of the Public Garden 2017).

Winthrop Center, the 775-foot high-rise proposal in the Financial District, east of the Common, would have violated the Common and Public Garden Shadow Laws up to 264 and 120 days of the year, respectively (Friends of the Public Garden 2016). In an open letter to legislators, Secretary of State and chair of the Massachusetts Historical Commission, Bill Galvin, expressed his concern for the project's flawed shadow analysis and damage to historical buildings. Due to the limited dates shown in the developer's shadow analysis, the extent of the building shadow's effect on public parks, private residences, and historical sites, including the State House, was not being duly considered (Logan 2017a, b; Treffeisen 2017b; Dumcius 2017). Galvin and Friends of the Public Garden cited the impact that permanent shadows can have on the public's use and enjoyment of the parks and historical sites, and damage to vegetation and natural ecology (Logan 2017b). They further argued that if the shadow laws were to be amended, the city would set a dangerous precedent of trading the value of their parks for revenue from developers (Friends of the Public Garden 2016). The plan was eventually

approved in 2018 by the Boston Planning and Development Agency (BPDA) Board and the project was allowed to proceed after an amendment to the shadow laws (Figure 3) (Greeley et al. 2018). The city received a total of \$163 million for the project's approval to be invested in open space and affordable housing, in addition to further payment by the developer to fund transportation and studies (City of Boston 2018).



Figure 3: Winthrop Center in Boston (MP Boston 2023)

The most recent project highlighting Boston's conflict between development and sunlight in parks is Longwood Place, a proposed office and laboratory development near Longwood Medical Area and the Riverway, part of the Emerald Necklace.

Figure 6.2a: Shadow Analysis - March 21
Longwood Place | Boston, MA



Figure 4: Shadow Analysis of the proposed Longwood Place development on March 21st (Emerald Necklace Conservancy 2025)

The project, which would add up to two hours of permanent shadow to the Riverway, continues to move forward despite violating the site’s interim guidelines set out by the BPDA, which restrict the building’s height and shadow (Figure 4) (Mauney-Brodek 2022a). With non-binding development guidelines and additional developer revenue, this project follows in the footsteps of Winthrop Center by perpetuating the ad hoc nature of Boston’s development process.

In 2022, Karen Mauney-Brodek, President of the Emerald Necklace Conservancy, a park stewardship organization and member of the project’s Impact Advisory Group, wrote open letters expressing concern with the project and advocating for stricter and standardized guidelines for development. She asserts that if the City is serious about systematic planning, “a true city-wide sunshine projection policy must be enacted to support and protect all of Boston’s parkland, environment, and communities” (Mauney-Brodek 2023). Writing directly to the City Project Manager for Longwood Place, she requested that the City of Boston

immediately start to develop a shadow policy for all parks citywide (potentially extending the existing shadow laws beyond the Common and Public Garden) that would standardize the inclusion of shadows in project review and eventual approval across the whole city (Mauney-Brodek 2022a). While Mauney-Brodek makes clear that she and the Conservancy are not in opposition to the project, standardized legislation for incorporating shadows into planning will allow this and future projects to go forward “while keeping necessary sunlight for the permanent public open space of the Emerald Necklace” (Mauney-Brodek 2023). This sentiment is echoed by other park organizations, including the national Olmsted Network and Boston legislators, but progress has been slow (Annear 2023; Petri 2023). In 2024-2025, the City conducted a study of shadow impacts on parkland, which they hope will provide a dependable methodology for establishing impacts that can then be anchored in the zoning code (City of Boston 2025e; Loth 2023).

With the establishment of the Boston Planning Department within the city government and reorganization of the BPDA by Mayor Michelle Wu in 2024, planning functions are reincorporated into the City Council’s oversight and budgeting (City of Boston n.d.b.). Additionally, the department oversees and facilitates the Article 80 development review process of Boston’s zoning code. Article 80, which defines the requirements for the development review process, lists several environmental reviews required by developers for large projects (>50,000 square feet), including studies of the project’s impact on wind, shadow, air quality, water quality, wetlands, and noise (see Boston Code §80B-3, 2) (City of Boston 2025b). For a shadow study, information must be provided indicating the shadow impact and skydome obstruction for build and no-build scenarios, with emphasis on public and open spaces (City of Boston 2025c). Once the shadow study is conducted, the developer is required to propose mitigation or impact reduction measures for any environmental harm reasonably attributed to the project. With the recent creation of the Boston Planning Department as a city office, an improvement process began in early 2024 to modernize Article 80 and the development review process to “shape growth that furthers the city’s goals of resilience, affordability, and equity through a process that is more transparent and predictable” (City of Boston n.d.c).

With a city-wide study in the works and these recent and ongoing procedural changes, now is the time for Boston to standardize its policy regarding project shadows and protecting sunlight in parks.

3. Methods

This thesis uses three qualitative methods – a literature review, case studies, and interviews – to analyze existing sunlight protection policies in cities in and outside the U.S., describe the need for such a policy in Boston, and recommend key policy elements needed to regulate building shadows near parks. While these policies exist under different names and with varying regulatory mechanisms in each city, I use the term ‘sunlight protection policy’ in a general sense to refer to a type of policy that regulates building development based on the shadow cover of a proposed project.

Literature Review

The literature review provides an understanding of urban green spaces and their social and ecosystem benefits, and the impact that added shadow from development has on these benefits. It also provides an overview of the current context in Boston, including existing shadow laws and ordinances, methods for valuing urban parkland, and key regulatory and non-regulatory tools available to protect sunlight access.

Background research builds on two open letters written by Karen Mauney-Brodek, President of the Emerald Necklace Conservancy, in which she writes to Boston Mayor Michelle Wu and the Longwood Place project manager advocating for a sunlight protection policy for parks city-wide (Mauney-Brodek 2022a; Mauney-Brodek 2022b). I used text, topics, and references from these letters to guide the literature review in its initial stages. Literature was collected through querying using the Tufts Library and Digital Archive, WorldCat, ProQuest, and Perplexity AI on the benefits of urban parks and sunlight access, and the impact of building and vegetative shade in parks and green space. Research and query keywords included: urban parks; urban green space and benefits; health benefits of parks; urban ecosystem services; value of sunlight; solar and sunlight access; urban shadow management; building shadow; shadow analysis.

Case Studies

I used case studies of cities with sunlight protection policies to understand how these policies came about and how they currently function in practice. San Francisco and New York City were identified through references from news articles and literature on cities with existing policies protecting parks from building shadow. The unit of analysis in each case is the policy itself. Each case supports the understanding of sunlight protection policies for application to Boston; what Robert Stake (1998) calls an “instrumental case study” and Robert Yin (2014) calls a multiple case study Type 3. The information gained shows precedents for policies in two U.S cities using different regulatory mechanisms and addresses implementation practices and difficulties for each. The information I gathered seeks out the uniqueness within each case, pertaining to the historical background, physical setting, social contexts, and available resources, which become important for later comparison and assessment (Stake 1998). Although not all these complexities will be studied in their entirety, their identification is important to qualify differences between cases. The results are compared to the current process for protecting parks from building shadows in Boston and are intended to inform policymakers and park organizations in the interest of a standardized policy to protect parks. Each case study is also informed by an interview with planners from each city’s Parks and Recreation Department (interview methods are discussed in detail below).

Data Collection

I gathered city zoning codes, other regulations and memorandums, and location-specific resources following similar methods to the literature review with the use of relevant keywords for each case and resources shared by interviewees. Additionally, I rely on archival review for primary sources such as news articles and legal documents from the time of the policy’s initial implementation and cases of subsequent use.

Cities

New York City’s City Environmental Quality Review (CEQR) requires a shadow assessment to be conducted for all projects of 50 feet or more in height or located adjacent to or across the street from a sunlight-sensitive resource (City of New York 2020). Such sunlight-

sensitive resources include all parks, open spaces, and natural resources. In the case of parks, the city’s Department of Parks and Recreation should be consulted for a shadow analysis. Home to the first U.S. zoning legislation, dense skyscrapers, and Olmsted-designed Central and Prospect Parks, New York City is well acquainted with the concern for sunlight access to many of its residents. Since the 2010s, bills proposing special legislation to protect parks from the shadows of supertall towers emphasize the necessity for considering shadows as part of the city’s comprehensive project review for park protection under extreme density (Bui and White 2016; Levine 2018).

San Francisco’s Planning Code Section 295, known as the Sunlight Ordinance, requires a shadow analysis and recommendation to the Planning Commission from the Recreation and Parks Commission for any proposed development over 40 feet tall that will cast any shadow on property under their jurisdiction (City of San Francisco 2015). This case study discusses how this policy came about and how shadows are considered in the city’s project review process to protect its 230 parks, playgrounds, and open spaces (City of San Francisco n.d.b.) and the impact this extra review has on the growth of the city.

Interviews

Conversations with members of the Parks and Recreation Department from each case study city provided insight into their city’s sunlight protection policies in practice and the role of their department and policy in protecting parks and green spaces. Interviews with local Boston and Massachusetts stakeholders provided information to apply the cases to the Boston parks context. I conducted seven interviews with the following individuals (Table 1):

Table 1. List of Interviewees

Name	Title	Affiliation
Liza Meyer	Interim Commissioner, Chief Landscape Architect	City of Boston Parks and Recreation Department (BPRD)
Jun Seung Lee	Engagement and Policy Manager	Emerald Necklace Conservancy (ENC)
Ruth Helfeld	Director, Landscape Architecture Section	Massachusetts Department of Conservation and Recreation (DCR)

Susan Hamilton	Assistant Deputy Commissioner of State Parks Operations	Massachusetts Department of Conservation and Recreation (DCR)
Yael Golan	Deputy Director of Planning, Capital and Planning Division	San Francisco Recreation and Parks Department
Chris Townes	Planner, Capital and Planning Division	San Francisco Recreation and Parks Department
Name withheld	Department of Environment & Planning	NYC Department of Parks and Recreation

The interviews were semi-structured to ensure that information is comparable across them while allowing for the option to focus deeper into specific topics unique to the interviewee (Bernard 2018). Each interview was conducted via video call and recorded for later review. These conversations provided examples of policy implementation and insights into successes and challenges that arise from regulating building shadows within the development process.

Interviews with Parks and Recreation officers reveal:

- The policy's intent
- The project review process under a sunlight protection policy
- Issues that arise around policy implementation
- How sunlight protection is balanced with other city needs in the review process

4. Literature Review

To inform my thesis, I reviewed the literature on the following topics: Frederick Law Olmsted and the Emerald Necklace, the benefits of urban parks, urban shade, valuing parks and open space resources, regulatory and non-regulatory solutions, and consideration of non-US cities.

Frederick Law Olmsted and the Emerald Necklace

Frederick Law Olmsted was born in Hartford, Connecticut, in 1822 into a nature-loving family, and grew up working on his farm on Staten Island, New York, where he experimented with horticulture, drainage, and soil improvements (Zaitzevsky 1982). During his time traveling in England, Olmsted was impressed by the countryside, private gardens, and public parks, particularly Birkenhead Park in Liverpool, which ignited his passion for landscape design and public spaces open to all (Raffetto 2025). In 1857, Olmsted secured the position of Superintendent of Central Park, where land had been cleared and earthwork had just begun (Ibid.). The same year, the Park Commissioners opened a design competition for the park. Olmsted partnered with British architect and landscape designer Calvert Vaux, who had set up a practice in New York, and entered the competition (Zaitzevsky 1982). The following year, in 1848, their design entry, the Greensward Plan, won the competition. Once the first sections were opened to the public in 1858, Central Park immediately became popular and highly visited, inspiring other cities to examine their own park needs.

In Boston in 1869, a petition by a citizen group made the first push towards a park system. During an 1870 lecture titled *Public Parks and the Enlargement of Towns*, Olmsted stated, “It is practically certain that the Boston of today is the mere nucleus of the Boston that is to be. It is practically certain that it is to extend over many miles of country now thoroughly rural in character” (Ibid., 39). Olmsted’s work in Boston officially began in 1878 when he left New York City after the creation of Central and Prospect Parks. An interconnected park system (as opposed to a large, central park) was required in Boston due to the natural topography of salt marshes in the Back Bay from the Muddy River and Stony Brook that drained

many of Boston's neighborhoods into the Charles River. Olmsted carefully selected park sites with a focus on creating accessibility "for all classes of citizen" and by many means of transportation (Ibid., 44): inner city parks were chosen near densely populated areas, intended to relieve sanitary nuisances; outer city parks were selected for their natural scenic beauty and rural character. Landscaped roads and streets called 'parkways' – a term coined by Olmsted and design partner Calvert Vaux while planning Prospect Park – are used extensively in the Emerald Necklace to establish scenic connectivity between parks and other urban features (Ibid.). While much can be said about the city of Boston's history and construction of these parks, it is important to understand Olmsted's values and intentions as they appear in the fabric of Boston's green space.

Olmsted's Theory of Design

The central themes of Olmsted's work in landscape architecture were his belief that nature has healing and restorative psychological effects on individuals and a belief in nature as a civilizing force in society (Nicholson 2004). Grassy parks in England and France were some of Olmsted's first inspirations. Although he recognized the futility of recreating these scenes in a new climate in the U.S., the pastoral style remained an important element of his designs:

Olmsted showed particular sensitivity and subtlety in balancing the pastoral (Beautiful) and Picturesque ideals and in interpreting both in terms of the particular geological terrain and native plant materials of whatever site he was asked to treat (Zaitzevsky 1982, 26).

To Olmsted, parks were not ornamental, they were part of the city's fabric and a force for future geographic, economic, social, and cultural growth. His holistic design approach included parks as pieces of a larger comprehensive city plan that incorporated the natural ecology of the area and current and future urban contexts. Central to Olmsted's park design philosophy was the ideal that every large city should have a large open park – a country park – along with a variety of other public grounds (Ibid.). In Boston, he intended to build a park large enough to give the illusion of infinite space based on his belief that contact with the natural world had the ability to preserve both physical health and mental tranquility, benefits that can't be achieved by public gardens, squares, other recreation grounds or sanitary improvements.

This country park would become the 527-acre Franklin Park located in Roxbury and the largest in Boston.

In Boston, as with Central Park in New York, parkland and open space design were deeply intertwined with urban sanitation and public health (Levine 2020). Olmsted's writings discuss the dangers of crowded cities making people high-strung and susceptible to disease, and the harms he felt came from too much exposure to artificial, urban scenery. His solution was rural scenery, which he believed gave an even stronger emotional impulse than the beauty of a curated space. Convinced that nature impacted human emotions both psychologically and socially, through an unconscious process, Olmsted valued urban parks as a resource for creating mental tranquility and a healthier state of mind (Nicholson 2004).

Public health – which in the mid-19th century referred to the physical wellness of the populace and its moral conduct and social configuration– was also of special importance to Olmsted and influenced the way he considered and designed urban spaces (Levine 2020). Critics of Olmsted's ideas consider them to be, today, a dated response to the “urban ills” of the 19th century, and that accessibility to such parks is less important with the availability of cars and rapid transportation (Zaitzevsky 1982). However, Olmsted's belief in the purifying effects of sunlight and foliage, and noncompetitive recreational uses of parks to create community have since been backed by science. Modern research shows the value of trees and green urban infrastructure in reducing air pollution and ambient air temperature (Bolund 1999; Dimoudi 2003), and their ability to promote health and recreation (Foderaro and Klein 2023) – discussed further in the Benefits of Urban Parks chapter. The Muddy River, a central piece of the Emerald Necklace, served this dual sanitary and aesthetic purpose; to “abate existing nuisances, avoid threatened dangers, and provide for the permanent, wholesome and seemly disposition of the drainage of Muddy River Valley Modern parks projects” (Emerald Necklace Conservancy 2022). The Muddy River Restoration, which began in 2007, reinforces Olmsted's original design and the value of the Muddy River to improve the flow of the river, stabilize its banks, control invasive species, and restore habitats for native wildlife.

Olmsted's social philosophy that motivated much of his work was communicativeness: a feeling of concern for one's neighbors and the common good (Nicholson 2004).

Communicativeness asked that individuals “serve others and [be] served by others in the most intimate, complete and extended degree imaginable” (Olmsted Network n.d.). This idea grew out of the fractured and antisocial society he encountered while living on the frontier in California during the 1850s and that was perpetuated through the Civil War (Ibid.). Olmsted believed that urban parks could counter this lack of connection between citizens by not only offsetting the physical the “ill effects” of the city but also by giving “people of all classes the opportunity to meet and mingle in casual friendliness, to enjoy the same circumstances,” and come together with a common purpose (Roper 1973, 318-319). This community-minded philosophy is evident in Olmsted's designs, which prioritize open spaces for recreation, relaxation, and social connection while also providing ecosystem services that create a healthy and more comfortable society in and outside his parks.

Benefits of Urban Parks

Spurred by a 14% increase in U.S. urban land area between 2000 and 2020, 83% of the U.S. population lives in urban areas as of 2024, and this number continues to increase (Center for Sustainable Systems 2024). Given the trend towards urban migration and development, urban parks are a crucial access point for the socio-cultural and ecological benefits of green spaces. Urban parks provide a range of benefits – both tangible and intangible – to adjacent communities, ranging from climate change mitigation to psychological restoration (Foderaro and Klein 2023; Lee, Jordan, and Horsley 2015).

Ecosystem benefits

The natural features of urban parks carry out ecosystem *functions* which include biotic, biochemical and abiotic processes, within the park and in connection with ecosystems across a city (Tzoulas et al. 2007). These ecosystem functions provide physical, biological, aesthetic, recreational, and cultural ecosystem *services*; defined as benefits derived by humans from ecosystem functions (Bolund and Hunhammar 1999; Tzoulas et al. 2007). In urban areas, air filtration, carbon sequestration, nutrient cycling, plant pollination, microclimate regulation, noise

reduction, rainwater drainage, sewage treatment, and recreational use are all services derived from parks and green space (Bolund and Hunhammar 1999; McDonald et al. 2024). Vegetation and urban tree canopies also mitigate the heat island effect by reducing summer air temperatures in and around parks (Dimoudi and Nikolopoulou 2003; Nowak and Greenfield 2012; McDonald et al. 2024)¹. The location and ecology of parks can allow them to protect us from environmental disasters such as heat waves and flooding, making parks a powerful tool for climate mitigation in cities (Foderaro and Klein 2023).

Bolund and Hunhammar (1999) make an important observation in discussing the benefits of urban parks; ecosystems, their services, and their values are site-specific, making research into the subject difficult to generalize outside the study site. Many location-based factors contribute to creating a healthy urban ecosystem that provides the widest possible range of benefits, and the causality between ecosystem services and public health and well-being can be viewed as bidirectional (Butler and Willis 2006). Functioning societies protect and enhance ecosystem services, while impaired well-being can lead to a decline in ecosystem services (Butler and Willis 2006). Furthermore, the benefits that humans gain from contact with ecosystems (cultural, psychological, and non-material) contribute to human health in urban settings (Tzoulas et al. 2007).

Human Health

A 2023 study by the Trust for Public Land provides evidence of public parks' ability to promote good mental, physical, and environmental health (Foderaro and Klein 2023). The study shows that in the top 25 ranked cities for their park systems, people are on average 9% less likely to suffer from poor mental health and are 21% less likely to be physically inactive than those in lower ranked cities (Ibid.). These benefits are largely attributed to parks acting as a venue for formal and informal physical activity, a platform for creating social connections, and the inherent benefit of prolonged time in natural areas. While this so-called inherent benefit can appear intangible, further research found that living near walkable green space has a direct positive influence on human longevity, highlighting the importance of green and walkable public

¹ The effects of urban shade from vegetation and buildings will be discussed further in the Urban Shade section.

spaces (Takano, Nakamura, and Watanabe 2002). Parks also contribute to reducing stress and health complaints (Van den Berg et al. 2010). Van den Berg et al. (2010) found that among their survey respondents, health complaints and perceived general health was significantly moderated by the amount of green space within a three-kilometer radius, “supporting the notion that green space can provide a buffer against the negative health impact of stressful life events” (Ibid., 1).

As a principal requirement for plant life in parks, sunlight is extremely valuable to humans. Modern research shows that sunlight is considered important to residential health, comfort, and daily living (Lau, Ng, and He 2011). Exposure to sunlight promotes the production of vitamin D which is associated with increased bone density and decreased prevalence of bone disease, and sunlight exposure early in the morning also maintains the regular production of melatonin at night, preventing insomnia, premenstrual syndrome, and seasonal affective disorder (Mead 2008). Evidence from various studies links low vitamin D levels seen in populations at higher latitudes to increased risk of some cancers and multiple sclerosis in adults (Mead 2008). In a survey of Hong Kong residents, Lau et al. (2011) found that sunlight coming into their residential unit was more important to 70% of survey respondents than even their view outside.

However, sunlight also comes at a cost for humans. Exposure to ultraviolet radiation from the sun has been attributed to DNA damage and skin cancers (Mead 2008). As extreme heat events continue to increase in their frequency and severity (Tong, McGregor, and Kinney 2021), park authorities in some states and cities are finding ways to increase the level of ‘human-scale’ shade cover² in parks to protect outdoor users from the harms of sunlight exposure (Stantec 2024; City of Toronto 2007). Mead (2008) describes growing concern among scientists that these efforts to protect against harmful solar exposure may be overshadowing research that shows the health benefits of carefully managed sunlight exposure, emphasizing the importance of sunlight in public green spaces along with healthy solar exposure.

² More on human-scale shade in the ‘Urban Shade’ section.

In addition to benefiting individual health, urban parks play an important role in creating social and health equity in cities. Zhou and Rana (2012) found that urban green space can provide extensive opportunities for recreation, social communication, aesthetic enjoyment, and education, along with promoting psycho-physiological health to city residents across differences in age, gender, profession, culture, and education. Access to parks also has an ‘equigenic’ effect³ in which they create especially strong health benefits among disadvantaged populations and those most likely to be in poor health by mitigating the “toxic effects of poverty” (Fyfe-Johnson et al. 2021; Foderaro and Klein 2023). This impact underscores the importance of equitable park and green space access for its role in improving health and reducing health disparities (Fyfe-Johnson et al. 2021).

Urban Shade

First, a distinction must be made between shade and shadow to understand and discuss these terms in urban policy and planning. In a 2018 report on the impacts of overshadowing by tall buildings, the City of Toronto clarified definitions and contradictions in the city’s shade and shadow policies.

Among planning, architecture and design professionals, the term ‘shadow’ has come to be understood as the deleterious absence of sunlight caused by a building, while among health promoters, ‘shade’ is understood to be a beneficial shelter from the sun’s harmful rays (City of Toronto 2018, 8).

This definition of shade is used in this thesis when I emphasize its beneficial nature regardless of the shade source. Shade can come from a number of different materials with varying implications for the urban environment that warrant further categorization. Human-scale shade is localized and has a limited impact. Trees, for example, cast shade that adapts to seasonal variations and provides human comfort:

This type of shade may best be considered health-promoting shade, shade-with-a-purpose, or healthy shade, as it allows for sun protection and/or personal protection from inclement weather, while allowing sun penetration in colder months (City of Toronto 2018, 8).

³ The term “equigenic” is used to describe “environments that act to disrupt the usual conversion of socioeconomic adversity to a greater risk of poor health” (Mitchell et. Al 2015).

In contrast, tall building shadow is unyielding, seasonally unvarying, spread over a larger area, and has long-lasting negative impacts on vegetation and the human enjoyment of green spaces. With regard to parks and green space, human-scale shade is primarily provided by trees and other vegetation and can also include some built shade structures such as pergolas, canopies, umbrellas, and overhangs near park benches and playgrounds. Tall building shadow refers to unintentional and unplanned shadow over a park from nearby buildings.

Shade in urban parks provides protection from long solar exposure, which promotes park use and comfort (Cimino, McWhirter, and Papadopoulos 2022) and creates cooling islands that combat urban heat (Aram et al. 2019). The urban heat island effect – the phenomenon in which urban areas become warmer than nearby rural and suburban areas – is caused by the highly efficient sunlight and heat absorption and radiation from the materials used in urban areas, primarily metal, concrete, asphalt, and brick (Tong, McGregor, and Kinney 2021). A study in 2018 showed that urban tree canopies make up a declining 39.4% of urban land cover in the U.S., while impervious surfaces increased to 26.6% of urban land cover (Nowak and Greenfield 2018).

A 3D land cover analysis at Ohio State University studied the effect of shadow and shade from different sources including buildings and trees on land surface temperature (Park, Guldmann, and Liu 2021). The research identified a gap in the literature focusing on 3D objects to study urban heat, with most prioritizing a 2D land cover analysis. By designating the shadow cast by tall buildings as a separate land cover type, they noted that a 1% increase in building shadow area leads to a decrease in land surface temperature of about 0.5% (Park, Guldmann, and Liu et al. 2021). They also found that each building façade not facing the sun lowers the building's overall impact on land surface temperatures, with additional marginal temperature reduction of each shaded unit area on rooftops and sun-facing façades. Surface type is also an important consideration for planning decisions. Building shadow and tree shade make an impactful difference on local surface temperature by reducing the thermal load of impervious grounds such as paved surfaces and railways (Ibid.).

Researchers studying shade use in public playgrounds in Ontario, Canada, recommend that all local governments use human-scale shade strategies to protect park users from

ultraviolet radiation for skin cancer prevention, promote park use for physical activity, and mitigate heat for thermal comfort and safety (Cimino, McWhirter, and Papadopoulos 2022). They suggest that improving shade availability will contribute to more sustainable environments by making the health benefits of shade more accessible (Ibid.).

Building shadow versus vegetative shade

Tall building shadows can provide some cooling, but when planning for outdoor recreation it is important to note the different benefits offered by human-scale and vegetative shade. Green spaces and the use of vegetative cover are effective and versatile solutions to reducing urban heat, and green infrastructure can provide a higher level of thermal comfort than other urban spaces (Aram et al. 2019). Green infrastructure, including green roofs and walls, street trees, and water retaining features, all reduce surface exposure to sunlight and air temperature (Tong, McGregor, and Kinney 2021), in addition to promoting biodiversity and the human health benefits of green spaces (Foderaro and Klein 2023). Tree cover is also an important factor in reducing the urban heat island. A threshold of 40% tree cover has been identified as reducing daytime air temperature by seven to nine degrees Fahrenheit (Ziter et al. 2019; McDonald et al. 2024).

The effects of vegetation are even more valuable at a larger scale. Large parks (over 10 hectares or 25 acres) have been shown to reduce air temperatures by 1-2 degrees C (33.8 – 35.6 degrees F) and extend this effect up to 350 meters (1,148 feet) from the park boundary (Aram et al. 2019). In contrast, larger building footprints with greater sun-facing rooftop and façade areas are becoming vulnerable to solar radiation and raising land surface temperature, while also taking away potential tree-planting space (Park, Guldman, and Liu 2021). The potential cooling impact of smaller parks has not been duly considered in the literature (Aram et al. 2019), but vegetative cover across a city at any scale is recommended for its ability to lower outdoor temperatures, decrease demand for building cooling, and other ecosystem services including sequestering runoff and carbon emissions (Tong, McGregor, and Kinney 2021). Green spaces provide enhanced cooling benefits during the summertime when trees reach their full potential for shade and evapotranspiration (Park, Guldman, and Liu et al. 2021).

The differences between building shadow and vegetative shade can also impact the ability for plants to grow, which has significant implications for development near parks. Tan and Ismail's (2014) study of how building shadow affects urban green space in Singapore quantified the difference between building shadow's and vegetative shade's reduction of photosynthetically active radiation (PAR). PAR, light within the solar radiation spectrum range that is usable by plants for photosynthesis, provides plants with nearly all their chemical energy needs and is essential for their ability to survive and grow (Tan and Ismail 2014). In two study sites, researchers found that PAR was reduced by almost 50% by high-rise buildings in a high-density urban environment compared to fully exposed conditions; this reduction correlated with lower vegetative and reproductive growth of certain shrub and tree species (Ibid.).

While some species are poorly adapted to shaded environments, others expect to receive sunlight through tree canopies. Vegetative canopies reduce red and far-red wavelengths which causes a response in plants that increases their growth and survival. Many understory plants are also adapted to receiving "sunflecks" exposed through gaps in the tree canopy that provide temporal increases in usable PAR that are not offered by shadows from a solid structure (Ibid.). While this study shows that building shadow does not entirely debilitate urban green spaces, it highlights the importance of photosynthetic energy availability for urban green spaces to provide their intended ecosystem services (Ibid.). The time and duration of sunlight availability must be considered alongside what plants and biodiversity are present to ensure that vegetation is able to survive and serve the park ecosystem.

Considering water and topography

Planning in and around parks also requires an understanding of the area's hydromorphology and the impact of temperature variation on these natural systems. An important example is Boston's Muddy River. The tributary of the Charles River had become heavily polluted by the mid-19th century, was cleaned up and redesigned by Olmsted in the 1880s, was buried during the city's development in the 1950s, and finally was daylit again in 2017 as part of an ongoing Muddy River Restoration Project (Emerald Necklace Conservancy 2024). The Muddy River was improved by Olmsted to provide "permanent, wholesome and

seemly disposition of the drainage” by dredging and expanding an existing waterway from Leverett Pond (in what is now Olmsted Park) through the Riverway and Back Bay Fens along his Emerald Necklace (Figure 5) (Emerald Necklace Conservancy 2024).



Figure 5: The south face of the Longwood Avenue Bridge and the Muddy River in the Riverway in springtime (Emerald Necklace Conservancy n.d.b.)

For parks that feature wetlands and surface water, lower temperatures from building shadow are a concern as they cause increased icing in wintertime (Lindberg and Grimmond 2011). Repeated freeze-thaw action near waterways, caused by frequent temperature fluctuation, reduces the shear strength (the soil’s ability to resist deformation under stress) and bulk density of the soil; under favorable conditions, one study shows that a single freeze thaw-

cycle can reduce soil shear strength by 50%, and “therefore increased numbers of freeze-thaw cycles will inevitably promote the rate of erosion” (Kaczmarek et al. 2019, 1147). Furthermore, slopes with western and southern exposure have been shown to experience a higher number of these freeze-thaw cycles than those with eastern and northern exposures due to their variation in temperature throughout the day and higher temperatures in the afternoon (Ibid.).

Added shadow could lead to the same erosion effect when considered in the context of Boston’s Muddy River and other waterways in parks. Daytime mean radiant temperature is lowest in dense urban environments, foremost due to building shadow, and shadow fractions grow larger during colder months due to lower sun altitude angles (Lindberg and Grimmond 2011). The Riverway is also frequently used as a walking commuter path for medical workers in the Longwood Medical Area that would be negatively impacted by icy conditions from lower temperatures (Mauney-Brodek 2022b).

Improper consideration of development casting shadows over parks and their waterways risks creating colder winter conditions that lead to erosion, impair the park’s walkability, and reduce its ability to retain stormwater and provide ecosystem benefits.

Shade in Policy and Design

While cities are seeking to increase the thermal comfort of citizens by providing tree shade and sunlight access for the winter times, they must also balance this goal with a need to build vertically to provide housing and prepare for increasingly warm temperatures year-round (Bozikovic 2023). Given these complexities, measuring and quantifying building shadow holds significant value to cities and the development of urban policy.

Shadows from the proposed Longwood Place onto the Riverway Park in Boston are of particular concern, and shadow analysts are employing a new method for calculating and evaluating the project’s potential shadow (Ying 2022). The city’s Interim Planning Guidelines for the site restrict any new shadow impacts on Boston parks to no more than one hour on the Vernal Equinox on March 21. To determine whether this is the case, analysts must differentiate between existing and new shadows, calculate the duration of shadows cast on the park, and then analyze and represent data efficiently and legibly (Ying 2022). Ying’s parametric analysis

calculated the difference between shadows with the proposed development and existing conditions to find any new shadows lasting more than an hour. While this data gives designers an understanding of the building's impact, the site's planning guidelines only required analysis of a single day which limits available, other information that could have implications for the building's design.

Some shadow analysts in architecture and planning are moving past a single-step analysis – computing shadow at a limited or single timestep – to incorporate accumulated shadow data (Omar et al. 2024). Accumulated shadow analysis conducted by Omar et al. (2024) incorporates shadow across 360 minutes (10:00 am - 4:00 pm) and assigns each pixel a value equivalent to the total number of minutes that a given point spends in shadow over the course of a day. This research focuses on creating a standardized and reproducible form of analysis that can easily be used and transferred to different cities with varying characteristics (Omar et al. 2024). The researchers say that analyzing accumulated shadow is fundamental to climate resilient urban planning. They write:

“During the winter months, these tools empower policymakers to optimize access to sunlight, thereby mitigating energy consumption and enhancing urban comfort. Conversely, precise shadow calculations foster thermal comfort during summer by strategically shading pedestrian pathways and outdoor spaces” (Omar et al. 2024, 11).

New York-based architect and shadow consultant Michael Kwartler encourages this type of analysis that considers shadows to be dynamic and focuses on shadow duration (Kwartler, cited in Bui and White 2016). He also states that the biggest threat to urban parks is simply bulky development on their southern border, allowing a greater amount of shadow to be cast over the park than from any other orientation. Much of the loss of public sunlight can be avoided through intentional choices of location and design for buildings (Bui and White 2016).

Although the warranted scale of analysis is determined by local policy, considering shadow impact along with other site-based factors is valuable to designers. In addition to knowing that sunlight access improves mental health and promotes green space and green infrastructure, designers need to understand a site's shadows to strategically locate and orient their building, design shade and control glare, and use proper building materials to mitigate

urban heat and increase pedestrian street comfort (Villagomez 2024; cove.tool 2023). Designing a building with the sun in mind benefits the building as it can act as a passive heating source that improves the building's energy efficiency and makes the property overall more valuable (Villagomez 2024).

Shadow analysis also helps designers create outdoor spaces and landscapes with vegetation adapted to the site's specific sunlight exposure and other conditions (cove.tool 2023). An innovative approach to designing for height and shadow reduction, developed by the architectural firm NBBJ, uses angles and reflective façades in twin towers that can reduce shadow by about 60%, providing some shade without "cloaking the sidewalk in darkness" (Ferro 2015). NBBJ intends to apply this design concept in cities across the world to balance the need for tall and dense housing options with allowing solar access at the ground level (Ibid.). Conducting these shadow studies allows new buildings to be optimized for a wide range of benefits and to document the buildings' impact on their urban context (Villagomez 2024; cove.tool 2023).

Valuing Parks

The lengthy and ongoing conflict over tall buildings, parks, and sunlight in Boston and other U.S. cities including New York City, San Francisco, Chicago, and Washington D.C. (Walsh 1991; Annear 2013; Badger 2015) is a testament to the value these parks hold to city residents. However, unlike many other city needs, the value of a park is less readily quantifiable, making it difficult to compare them to real estate assets such as a residential or commercial development. This section reviews existing frameworks for measuring the ecological and social values derived from parks.

The inability of planners and researchers to value parks in economic terms causes parks to be under constant development pressure in urban environments (More, Stevens, and Allen 1988). Planning for urban green spaces must be done in collaboration with other government priorities, including housing and transportation, and assigning values to ecosystem services allows them to be better addressed in this process (Lee, Jordan, and Horsley 2015). To calculate damages to natural resources such as parks, the U.S. EPA (2024) uses 'use' and 'non-

use' values. Use value equates a dollar amount to the public's use of natural resources which are not traded in a marketplace (U.S. EPA 2024). Non-use value can come from a variety of sources. 'Bequest,' 'existence,' 'intrinsic,' and 'passive' values are all terms used in economics literature to describe natural resource values not related to present use of the resource (U.S. EPA 2024).

More, Stevens and Allen (1988) divide the valuation of parks between 'on-site' and 'off-site' benefits. On-site benefits, similar to use values, are accrued directly by those using the parks and can be equated to the cost of facilities and equipment to include both active and passive recreational use values (Ibid.). To do this, valuation methods quantify the economic implications of human behavior. The 'travel cost' method values parks by assuming that the economic benefit of a park is equivalent to the cost burden to travel to that park for the farthest park user (More, Stevens, and Allen 1988). Contingent valuation is another method used, which asks park users to quantify their potential willingness to pay for use of the park (Ibid.).

Off-site park benefits, those accrued by people outside the park boundaries, include physical benefits such as air quality improvement, pollution reduction, habitat, and sites for monuments and memorials, as well as the existence value of having a park nearby (Ibid.). Valuing these non-market benefits of parks is commonly done using Hedonic Pricing, observing behavior in property markets to determine the effect of nearby non-market resources (Ibid.).

In 2003, the Trust for Public Land sponsored a study by park experts and economists to analyze how parks economically benefit cities (Harnik and Welle 2009). Seven major and measurable attributes of urban parks that add economic value to their cities were identified (Table 2).

Table 2: Value of parks from studies compiled by the Trust for Public Land

Park Values in Action				
Value Type	Value	Case City	Valuation Method	Value Attributed to Parks (2025 USD*)
Economic Value	Property Value	Washington D.C.	Hedonic Pricing of properties within 500 ft of a park.	\$1,897,490,160.38 (property value attributed to parks) \$10,700,665.76 (property tax from property values due to parks)
	Tourist Value	San Diego, CA	Calculated using city data and phone survey.	\$63,362,200.38 (net profit to the city)
Cost Savings	Direct Use	Boston, MA	Calculated using a park use survey and assigned dollar values to each use.	\$560,850,561.19 (abstract)
	Human Health	Sacramento, CA	<u>Parks Health Benefits Calculator</u> (NRPA)	\$30,581,135.47 (medical savings)
	Community Cohesion	Philadelphia, PA	Calculated using financial contributions to 'friends of parks' organization and dollar values of volunteer labor given to parks (\$28.85/hr (2025))	\$13,235,273.35 (abstract)
Environmental Savings	Stormwater Management	Philadelphia, PA	Calculated using estimate of runoff reduction from parkland and stormwater management cost per cubic foot (1.2¢)	\$9,154,417.98 (totals savings from runoff reduction)
	Air Pollution Removal	Washington D.C.	Calculated using total tree cover area, volume of pollutants removed, and dollar values assigned to pollutants.	\$32,466,737.27 (total savings from air pollutant removal)

Source: Harnik and Welle 2009. Dollars adjusted for inflation using the U.S. Inflation Calculator (2025).

The first attribute is parks' ability to increase property value and provide direct income to cities (Ibid.). Measured using hedonic pricing models, another study in Beijing found that proximity to urban parks was associated with a housing price premium of up to 6.3% (Ma et. al. 2024). Property values were shown to be the highest for houses between 100m and 300m (328 to 984 feet) from a park and impacted the most by parks 20-50 hectares in size (49 to 124 acres) (Ibid.). In a study of Washington D.C., over \$1 billion in property value was attributed to proximity to parks, leading to just over \$10 million (in 2025 dollars) in annual property tax capture from parks (Harnik and Welle 2009). Tourism associated with parks can be compared to other market resources using the travel cost method and surveys or other urban data collection practices, and provides direct income to cities through sales taxes and contributions to the city's collective wealth (Harnik and Welle 2009).

Three other benefits – direct use, health benefits, and community cohesion – were all identified as benefits of urban parks that offer cost savings for their cities (Ibid.). These savings come from encouraging free and low-cost use of public space, improved physical and mental health, and social capital, which can be quantified through such things as avoided market purchases, reduced medical costs, and reduced social problems that may cause increased social services costs to the city (Ibid.). An urban greening study in the U.S. observed that urban greening reduced gun crime and vandalism, and a subsequent increase in physical activity of nearby residents which may be associated with a greater willingness to use the newly “cleaner, greener, and safer environment” (Lee, Jordan, and Horsley 2015). Other determinants of green space use and value include availability, accessibility, perceptions of hygiene and security, and quality of space with regard to natural and recreational features and appeal to different population groups (Ibid.).

Two additional benefits identified by the Trust for Public Land study are clean water and air, which provide cities with environmental savings and pollution reduction that decrease city spending on stormwater management and pollutant removal (Harnik and Welle 2009). Studies have shown tree cover's ability to reduce energy demand for indoor cooling to be anywhere from 2.3% to 90% (McDonald et. al. 2024). This both lowers total spending on energy and reduces emissions of greenhouse gases from electricity generation. Additionally, forests

sequester carbon which further improves air quality by passively removing greenhouse gases from the ambient air (Ibid.).

Regulatory and Non-Regulatory Tools

Determining how best to protect parks warrants consideration of tools used to protect comparable resources. In this section, I discuss aspects of regulatory and non-regulatory programs used to protect solar access and land conservation, and how they could be applied to regulating sunlight protection for urban parks.

Sunlight is beneficial to both human and ecological health, a relationship that is well documented and reflected in hedonic pricing models (Fleming et al. 2018). Through a comparison of average daily sunlight received on a property, home sale prices and other property characteristics, Fleming et al. (2018) determined that a housing price increased by 2.6% for each extra hour of sunlight received per day. However, the researchers note that there is a gap in the literature regarding the valuation of sunlight for urban economics and city planning, and as such, the loss of sunlight isn't properly considered as a negative externality (Ibid.).

The issue of solar access, the potential shading of sunlight sensitive resources — particularly solar collectors — by neighboring structures or vegetation, has been addressed by various planning laws throughout history (Kettles 2008). The issue can be divided between the ability to install a private solar collector and the ability for a property to receive unobstructed sunlight across property lines, what Kettles (2008) refers to as 'solar rights' and 'solar easements.' Bronin (2009) uses the term solar rights to holistically refer to the rights to access and use sunlight — “The right to access and harness the rays of the sun” (1218).

Since the ability to access sunlight is most comparable to the rights necessary to protect sunlight in parks, Bronin's definition of solar rights will be used. In the case of solar collectors, as in parks, sunlight is both necessary and contingent on its free movement through neighboring property (depending on the time of day), meaning that to receive its benefit requires agreements or laws shared between neighboring property owners and across a city. Solar rights can have high economic value, affording property owners the ability to grow crops, operate

solar energy collectors, illuminate spaces, and increase resale price while reducing many operating costs (heating, cooling, lighting), but they are also difficult to negotiate (Bronin 2009). By necessity, solar rights implicate neighboring properties both nearby and further away which is why they have not been largely recognized by the U.S. legal system (Ibid.). One of the oldest solar access laws was the “Doctrine of Ancient Lights,” rooted in the English common law from 1663 (Tikkanen 2008). In the U.S., this was formally rejected by at least one court (see Fontainebleau v Forty-Five Twenty-Five, Inc. 114 So. 2d 357 (1959)) which held that there is no common law right to sunlight (Kettles 2008).

Government-allocated solar rights

Without a common law right to sunlight, there are certain ways that cities and towns can use regulations to plan for solar protection. Massachusetts specifically allows for “solar easements” to be placed on “vegetation, structures, and other objects which would impair or obstruct the passage of sunlight.” (see Massachusetts General Law (M.G.L.) c.187 §1A) (Commonwealth of Massachusetts 2025). Easements give a property owner certain rights over another property, either use of their property or restrictions on the other owner's use (Bronin 2009). The ‘burdened’ property owner grants a solar easement for the light within their property’s airspace to the ‘easement holder.’ Development on the burdened property is now restricted to ensure the easement holder’s unobstructed access to sunlight across the burdened property. Massachusetts also allows for zoning ordinances to protect sunlight access and allocation of sunlight access permits (see M.G.L. c.40A §9B) (Ibid.).

Some state and local governments grant easements through a permitting scheme, where the initial entitlement is given to those who already have solar rights⁴, while rights seekers “must apply to change the default” (Bronin 2009). This system introduces uncertainty into the

⁴ According to Bronin (2009): “Several states and localities have experimented with permit systems that allocate solar rights based on criteria analogous to the prior appropriation regime or reasonable use requirements in water law” (1237)

process as applications are reviewed on a case-by-case basis, and a solar right granted to one property is likely to affect the development rights of a neighboring property⁵ (Ibid.).

Conversely, solar zoning ordinances set solar rights as a baseline (Ibid.). Massachusetts law allows zoning ordinances to regulate street orientation, lot and building size, setback requirements, type, height and placement of vegetation, and establish buffer zones and solar protection overlays over existing zoning districts (see M.G.L c.40A §9B) (Commonwealth of Massachusetts 2025). Although it does not explicitly identify sunlight protection, Boston's Parkways Ordinance is an example of a zoning ordinance that requires impact review and approval by the Parks and Recreation Commission to provide solar rights to parks (see Boston Code Article 7-4.11) (City of Boston 2023a). Zoning's rational basis reduces uncertainty through the public process and avoids challenges of takings, equal protection, and due process, making it a critical tool for providing solar access⁶ (Bronin 2009). Since city planning is generally overseen by one public body, solar zoning ordinances and permits are procedural and relatively low-cost solutions to allocating solar rights at a large scale across an urban area (Ibid.).

Master Planning

Local land use and master plans can also address solar access and adopt policies that incorporate it into the planning process (Kettles 2008). Massachusetts law requires that all cities and towns create a planning board and a master plan which will provide "a basis for decision making" for future development (see MGL c.41 §81A and §81D) (Commonwealth of Massachusetts 2025). Boston, however, is exempted from this requirement, and the city's planning board powers have historically been delegated to the BPDA⁷ (Boston Policy Institute 2024). Though not required to do so, in 2017, Boston approved and adopted *Imagine Boston 2030*, a "general plan", and the Boston Planning Department's Comprehensive Planning Team (established in 2024) creates long term plans for land uses, housing needs, historic preservation,

⁵ According to Bronin (2009): "The case most likely to be used to measure [a] skyscraper builder's takings allegations is Penn Central Transportation Co. v. New York City, 438 U.S. 104 (1978), which established a three-factor balancing test to weigh takings cases" (1242).

⁶ According to Kettles (2008): "There is a strong presumption of validity of a local ordinance, since local officials are in a better position than the courts to have knowledge of any local conditions upon which the ordinance is predicated."

⁷ Although Mayor Michelle Wu established Boston's Planning Department in 2024, the planning board remained an independent function of the BPDA Board (Boston Policy Institute 2024).

open spaces, transportation networks, health and safety, and economic development at citywide and neighborhood-specific scales (McCormick 2017; City of Boston n.d.a.). Although master planning is not compulsory in Boston, it is still an option that the city has exercised in the past and could in the future encourage protecting solar access.

Privately Negotiated Solar Rights

Express agreements of solar easements can be negotiated between private parties and are the most straightforward and efficient method for privately negotiating solar rights (Bronin 2009). The voluntary nature of these agreements is designed to guarantee a mutually agreeable result, which is not necessarily assured under a government-allocated solar rights regime, and potentially avoid a lengthy bureaucratic process (Ibid.). This process, however, can lead to owners burdened with easements charging high values for the right to their property in addition to high bargaining costs (Ibid.).

Restrictive covenants are another form of private agreement that can be used to award solar rights. These agreements run with the land which avoids a bargaining process as purchasers have implicitly agreed to the terms, and the costs are generally incorporated into the purchase price of the property by the next owner (Ibid.). Restrictive covenants often apply to many parcels of land within a region which makes them appear fairer, though historically this has been used in practice to force regional homogeneity (Ibid.). Since urban parks are publicly owned, there is likely very little incentive for neighboring private property owners to voluntarily negotiate an easement to restrict development on their own property, so local ordinances can be adopted to promote solar access and the use of easements for parks protection. Massachusetts law allows planning boards to set standards regarding restrictive covenants to protect solar access (see M.G.L. c.41 §81Q), though in Boston, the BPDA has not exercised this ability (Commonwealth of Massachusetts 2025).

It is important to note that in Massachusetts, solar easements cannot be created by implication and require some statutory authority (see M.G.L. c.187 §1) (Commonwealth of Massachusetts 2025; Kettles 2008). As such, no amount of enjoyment of sunlight (in a house or a park) constitutes a right to that use or enjoyment. Additionally, enough influence and purchasing power may not be readily available to create private agreements for protecting

public parks on their own. Local ordinances are created to promote the public interest in the context of current events (Ibid.). Just as energy policies are shifting towards encouraging the use of renewable energy, local officials may also find that development easements to protect sunlight on public parks are shifting into a public priority as well.

Conservation Restrictions

Conservation restrictions, known outside of Massachusetts as a conservation easement, offer another precedent for protecting and valuing open spaces (see M.G.L. c.185 §30-33) (MassWoods 2025). These agreements restrict some or all development rights to ensure that their land continues to produce ecosystem services and environmental benefits while retaining ownership of the land, and have been used to protect resources including farmlands, forests, viewsheds, trails, wetlands, groundwater, and historical and cultural sites (Plantinga 2007; MassWoods 2025). While solar easements are usually agreements between individual property owners, conservation restrictions are often purchased by private groups such as land trusts at local or regional levels, and local, state, or federal government agencies (Plantinga 2007).

Conservation easements have become increasingly popular in the U.S., as can be seen by the growing number of federal and state funds and use of land trusts, and many studies have shown a positive effect of conservation easements on property values in the long term (Ibid.). Given the high value placed on community cohesion and prominence of urban parks organizations by the Trust for Public Land (see Table 1), purchasing vertical easements restricting building heights to protect parks may be a viable alternative for parks advocates with enough capital to subvert the public process.

Considering Non-U.S. Cities

Melbourne, Victoria, Australia

Outside the United States, the City of Melbourne in Victoria, Australia, is also working to preserve sunlight in their parks with a special focus on winter sunlight access. Although their amendment to the city's planning scheme proposed in 2021 has not been implemented, the city

conducted a substantial study to understand sunlight needs and how they can be reflected in policy (City of Melbourne 2024).

The study, by Hodyl & Co, considered sunlight access from a user perspective in public parks to “establish appropriate sunlight levels for public parks,” incorporating the critical role of winter sunlight on human health (Hodyl, Fitzgerald, and Collie 2018, 4). Their research identified negative health impacts associated with the wintertime including Vitamin D deficiency and decreased physical and mental health (Ibid.). As such, winter sunlight access is necessary to ensure equitable health benefits of its parks and was identified as priority number one for an amended planning scheme (Ibid.). One expert stated that “open space with direct sunlight in the winter makes it more appealing, warmer and more comfortable to use which will encourage people outdoors allowing them to benefit from exposure to natural sunlight” (Thompson 2021, 29).

The report proposed a shift away from the standard of measuring shadows at the spring and fall equinoxes to focus on maximizing sunlight and minimizing shadow during winter months (Hodyl, Fitzgerald, and Collie 2018). The report’s second priority is to balance these winter sunlight needs with the need to support development in the city (Ibid.). Since creating new open space is very difficult for the city, the report suggests that policy should introduce local sunlight protection that is “directly related to the scale of development that has already been considered appropriate for the area” (Ibid, 9). This tailored policy can balance retaining sunlight on parks which planning for the Melbourne’s future growth (Ibid.).

Toronto, Ontario, Canada

Toronto, like Boston, experiences four seasons and is preparing for a growing population and worsening extreme weather conditions in a changing climate (City of Toronto 2025). A 2018 study on the impacts of building shadow on green space in Toronto concluded that tall buildings significantly impact their surrounding microclimates, and planning and development in the city should “account for the heating and cooling effects of the sun and interactions between buildings, adjacent trees, and green (City of Toronto 2018, 2). Previous guidance from the city focused on the need to provide shade in parks to reduce solar

ultraviolet radiation exposure and decrease skin cancer risk, especially among children (City of Toronto 2007).

Recently, Toronto identified a need to update its guidelines on ‘thermal comfort’, to adapt the city’s use of outdoor public spaces to a changing climate. Thermal comfort, “the state of feeling neither too warm nor too cold in a given environment,” is largely determined by air temperature, humidity, wind speed, and radiant temperature (Figure 6) (City of Toronto 2025, 7). Especially during extreme heat events, parks and open spaces “may become places of refuge for people of all ages and abilities [...]. The design of these spaces, with thermal comfort in mind, is essential to building a resilient city capable of withstanding the growing impact of climate change” (Ibid, 13).

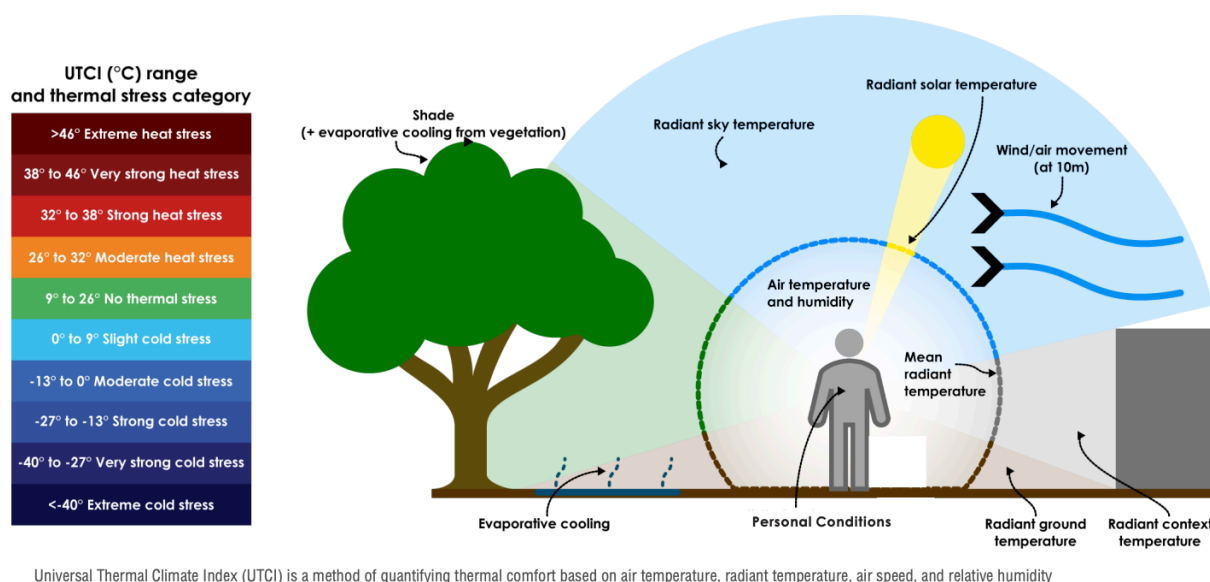


Figure 6: Universal Thermal Comfort Index thermal stress ranges and factors influencing thermal comfort (City of Toronto 2025, 22).

By enhancing its understanding of thermal comfort, Toronto is looking to reshape its development guidelines to prioritize open space equity, use a “life-centric” approach that includes human and vegetative comfort, consider different transportation uses, and achieve seasonal shade and comfort with a special focus on the “shoulder seasons” of spring and fall to extend opportunities for use of outdoor spaces (Ibid.). Using these thermal comfort guidelines, which were adopted by the city in February 2025, Toronto seeks to “enhance the joy of urban

living, regardless of the season”, and encourage dynamic and vibrant urban life in the city through planning that focuses on thermal comfort (City of Toronto n.d.; City of Toronto 2025, 9).

5. Case Studies

New York City, New York

New York City holds the title of both the most populous (8.8 million residents) and densest (29,298 residents per square mile) city in the United States (Zaidi 2024). Known for its Olmsted-designed Central and Prospect Parks, the city is home to over 30,000 acres of parkland, constituting 14% of the city's land area (Figure 7) (City of New York n.d.).

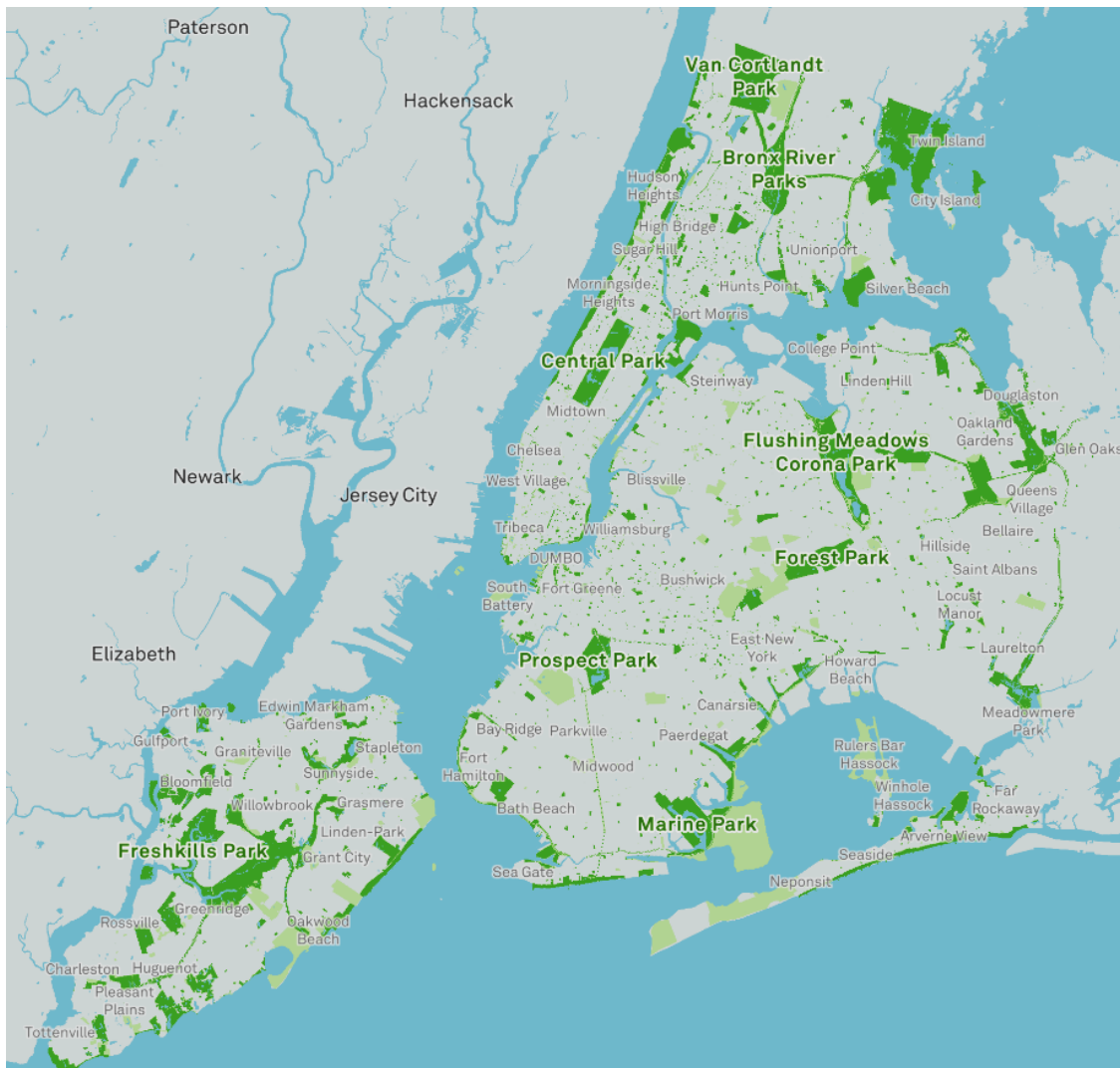


Figure 7: Map of New York City Parks (NYC Parks n.d.)

New York City's Parks and Recreation Department (NYC Parks) stewards over 5,000 individual properties, including playgrounds, beaches, athletic fields and courts, community gardens, Greenstreets, and 666,000 street trees (Ibid.). The city's size and density have raised a history of concern surrounding the threat its massive developments pose to public health, reinforcing the importance of its parks and open space features.

Central Park itself, built in 1858, was intended to provide an oasis from the city for "the sanitary advantage of breathing," according to Olmsted (Levine 2020, 1). The value of sunlight access and concerns over building shadows in New York City inspired its first zoning resolution in 1916 and continues to be an important consideration in its land-use planning today (Botham 2021).

Planning and Shadow History

In their Second Annual Report to the Commissioners of Central Park, Olmsted and partner Calvert Vaux state that "the primary purpose of the park is to provide the best practical means of healthful recreation for the inhabitants of the city of all classes" (Levine 2020, pg. 15). As the city continued to grow around the park, this purpose was increasingly threatened. In 1915, in the financial district of Lower Manhattan, the Equitable Building was completed, at the time the largest office building in the world. The 555-foot-tall, 1.2 million square-foot building was designed without setbacks, occupied an entire city block, and cast seven acres of shadow on neighboring streets and buildings. Surrounding property values dropped. The backlash over the shadows crowned decades-long efforts by planners to reduce building heights in New York and other cities and finally led to one of the country's most influential building code changes, New York City's 1916 Zoning Resolution (Botham 2021). The resolution, which regulated and limited the height and bulk of buildings required setbacks at height intervals leading to a design shape now ubiquitous across the city known as the "wedding-cake" or "setback-and-tower" (Figure 8) (City of New York 1916; Botham 2021).

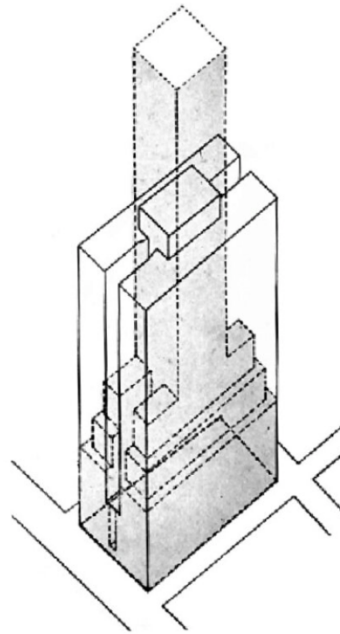


Diagram showing the impact of the 1916 Zoning Resolution in New York. The zoning laws changed to require buildings to set back from their lot lines as they grew taller, resulting in large, bulky bases and slender towers.

Figure 8: Diagram showing the impact of the 1916 Zoning Resolution in New York (Botham 2021).

“[This diagram] shows a comparison between the Equitable Building and a second massing that conforms to [1916 Zoning Resolution]. The solid lines represent the Equitable Building, and the dotted lines represent the setback rules established by the zoning laws. The taller a building was, the more it had to set back from its lot line. This resulted in buildings with large, bulky bases and slender towers. Buildings shaped like this became known as wedding-cake or setback-and-tower structures, due to the systems of setbacks involved as they rise from the street” (Botham 2021, pg. 4).

A new zoning code resolution in 1961 was specifically designed to mitigate shadows by limiting the floor plate of each story and allowing the sale of air rights, leading to buildings slimming even more as they grew taller (Barr 2018). In the 2000s, this inspired the construction of supertall towers (discussed later in this chapter), some reaching over 1,400 feet, surrounding Central Park in Manhattan (Barr 2019).

While the city’s zoning ordinances set guidelines for building design, New York’s City Environmental Quality Review (CEQR) process addresses the environmental impacts of all city

projects. In 1973, the mayor enacted the Environmental Review of Major Projects Executive Order as a local adaptation of the federal National Environmental Policy Act (NEPA) enacted in 1970 (City of New York 2021). Two years later, in 1975, the New York State government enacted the State Environmental Quality Review (SEQR) Act, a state-level NEPA adaptation, and in 1977, CEQR was officially established with revised procedures via Mayoral Executive Order to implement SEQR within the city (Ibid.).

The CEQR requirements, procedures and guidance for areas of environmental impact analysis are described in depth in the CEQR Technical Manual (the Manual) (Ibid.). CEQR's goal is to "review proposed discretionary actions to identify and disclose the potential effects those actions may have on the environment," and offer options for mitigation (Ibid., I-1). As such, the Manual describes procedures and recommendations for assessing a wide range of environmental features, the most relevant being shadows (Chapter 8) as well as open space, historic and cultural resources, and natural resources (Chapters 7, 9, and 11).

Like NEPA, this review is triggered by discretionary action – any action taken directly by or requiring approval or funding from the city – and outlines three types of actions warranting different levels of environmental review. Type II actions are those that are pre-determined to have no significant environmental impact, typically maintenance and repair or reconstruction, and so are not subject to environmental review. Actions requiring environmental review are Type I actions, those actions with a "presumption that it is likely to have a significant adverse impact on the environment," and Unlisted actions, those that are not listed as either Type I or Type II (Ibid., I-4). The CEQR process also designates a lead city agency in charge of approving or funding the project. It is recommended that the lead agency consult with other agencies as relevant, but they retain the final say in the project's approval. The city's Uniform Land Use Review Procedure (ULURP) occurs simultaneously with CEQR's environmental review for all private development applications and offers additional opportunities for public input in the project approval process, with the Department of City Planning acting as the lead agency (Figure 9).

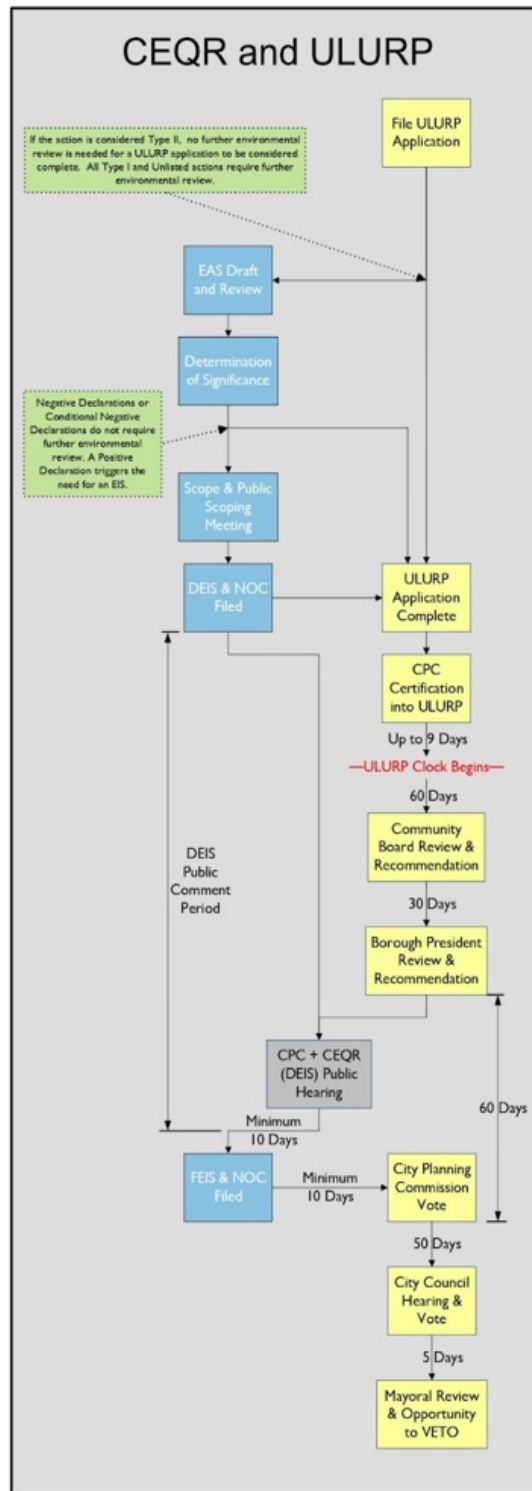


Figure 9: Chart showing the relationship between CEQR and ULURP (City of New York 2021)

CEQR Chapter 8: Shadows

The technical requirements for shadow assessments and guidelines for determining impact significance are described in detail in Chapter 8 of the Manual, which received a substantial update in 2021 (City of New York 2021; NYC Parks 2025). A shadow assessment is required for a project if it is either a new structure or addition to a structure reaching 50 or more feet in height, or if the project is located adjacent to or across the street from a 'sunlight-sensitive resource'. Sunlight-sensitive resources are defined as "those resources that depend on sunlight or for which direct sunlight is necessary to maintain the resource's usability or architectural integrity," and include city parks, Greenstreets and vegetation as well as historical landmarks and natural resources (City of New York 2021, 8-1). Depending on the sunlight-sensitive resources considered in the shadow assessment, the lead agency is recommended to consult with an 'expert agency': NYC Parks for open space resources, the Landmarks Preservation Commission (LPC) for architectural resources, or the Department of Environmental Protection (DEP) for natural resources. The primary concern when addressing the impact of 'incremental' shadow (shadow added by the proposed project) is its potential to alter public use or enjoyment, or to threaten the viability of vegetation.

Although the shadow assessment procedure is the same for each project, results and impacts are considered on a case-by-case basis (City of New York 2021; NYC Parks 2025). Multiple stages of assessment also allow the possibility for shadow impacts to be screened out along the way, eliminating the burden of a full technical analysis when it is found to be unnecessary. Projects that warrant a shadow assessment begin with a preliminary screening, including a basemap featuring the proposed building site and nearby sunlight-sensitive resources. The Tier 1 assessments identify the study area as a radius around the proposed building site equal to the longest possible shadow that the proposed structure could cast. If any portion of a sunlight-sensitive resource is within this study area, the Tier 2 assessment screens out the area south of the site that cannot be shaded due to the angle of the sun (in New York City this is between -108 and +108 degrees from true north) (Figure 10). If sunlight-sensitive resources are still within the study area, a Tier 3 assessment is conducted using 3D computer modeling

software to most accurately view the shape and trajectory of the shadow from the proposed building.

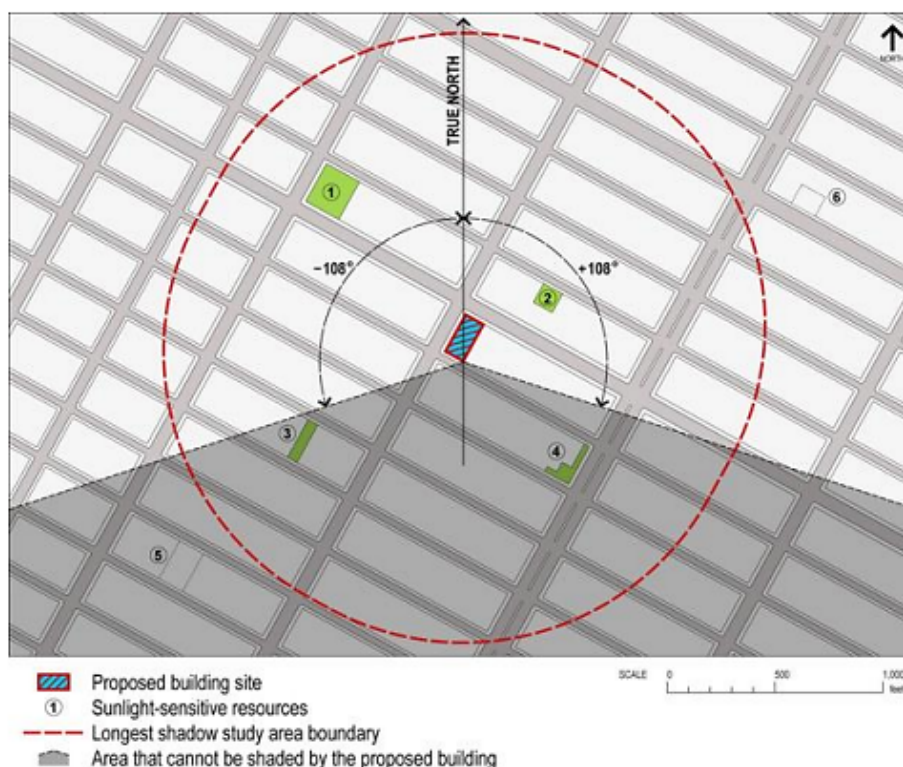


Figure 10: Shadow fan map showing area that can and cannot realistically be shaded by the proposed project. Part of New York City's evaluation process of the shadow impact on parks and other resources of proposed projects. (CEQR 8-6)

This assessment addresses shadow between 1.5 hours after sunrise and 1.5 hours before sunset at representative times of year. The vernal or autumnal equinoxes (March 21 and September 21), the summer solstice (June 21), and one date between either of the two (May 6 or August 6) are used to represent sunlight available throughout the growing season, which is especially important for open spaces with both natural vegetation and cultivated community gardens. The winter solstice (December 21) is also typically included to represent cold-weather months in which open space users are most reliant on sunlight for warmth.

A detailed analysis is conducted for any of the representative dates on which the potential for shadow to reach a sunlight-sensitive resource could not be ruled out. This builds on the existing 3D computer model to include shadows present in a no-build scenario to identify and document the extent and duration of incremental shadow from the proposed project.

Once incremental shadow from the proposed project has been identified, the Manual provides a guide for determining impact significance (City of New York 2021). At baseline, six to eight hours of sunlight is required for all sunlight-sensitive resources, though determining impact is heavily dependent on the needs of the resources being shadowed. Open space and natural resources are inherently sensitive to shadows by both their features and uses. Warm-weather-dependent features such as playgrounds, pools, and vegetation may be impacted by reduced use or viability from lack of light. Loss of winter sunlight can impact the use of park benches and recreational areas that rely on sunlight for warmth, as well as vegetation that photosynthesizes in the winter such as evergreen trees.

In parks, vegetation, tree canopies, flowering plants, and community garden plots have different sunlight needs based on species and placement which must all be considered in a determination of significant impact. Lead agency collaboration with expert agencies including NYC Parks is especially important for determining the impact of shadows on unique sensitive resources such as botanical gardens and food-producing urban farms since these often feature diverse species for specific purposes making them extremely sensitive to changes in sunlight and other environmental conditions. Sunlight-reliant park uses, both passive (sitting or sunning) and active (play fields, sport courts, gardening, recreation), must also be considered (City of New York 2021; NYC Parks 2025).

For all sunlight-sensitive resources, a significant impact is officially determined where the shadow assessment shows that the proposed structure will cause an incremental shadow lasting ten or more minutes that leads to a “substantial reduction” in available sunlight on a sunlight-sensitive resource (Ibid. 8-28). For vegetation, this means a reduction in sunlight below the minimum sunlight needs of the present species, or reduction of direct sunlight exposure where there is already substandard sunlight availability. Short- and long-term impacts of changes in

sunlight duration on vegetation include death of the plant or changes in bloom time or color. Significant impact on open spaces can also be determined where increased shadows substantially reduce the usability of that space.

For historic and cultural resources, a substantial reduction in available sunlight may reduce the enjoyment or appreciation of these resources. The complete elimination of all direct sunlight from a feature of a sunlight-sensitive resource which may impact the survival, enjoyment, or use of the resource is also considered a significant impact. Though not technically required, it is “appropriate to *consult with* the government agency under which jurisdiction of the affected sunlight-sensitive resource falls” (emphasis added) when determining impact significance (Ibid., 8-28).

If a significant impact is determined, the lead agency must assess potential strategies to mitigate their incremental shadow. These begin with modifications to the building bulk (height, shape, size, and orientation on the site), and if necessary, could extend to the relocation of sunlight-sensitive features within an open space and redesign or reorientation of open spaces to replace impacted features in collaboration with NYC Parks (Ibid., 8-30-31). Collaboration with LPC and DEP is encouraged to assess mitigation strategies for historic and natural resources. Relocating the project itself to a different site is also an alternative to be explored when appropriate if significant shadow impact has been identified.

After the analysis of incremental shadows, impact determination, and assessment of alternatives, the results are compiled along with the other conducted environmental reviews into a draft environmental impact statement (EIS). This draft EIS is published and opened for a public comment period which concludes with the publishing of a final EIS and statement of findings. Even though impacts and alternatives have been identified and considered, CEQR is only a disclosure process, so these findings have no decision-making power on their own (City of New York 2021; NYC Parks 2025). Instead, they are considered before the City Planning Commission vote at the end of ULURP (Figure 7).

Projects Requiring Shadow Assessment

Many recent projects have raised concern in the public process over building shadow impacts. In 2015, the executive director of a local organization, New Yorkers for Parks (NY4P) testified at the New York City Council Committee on Parks & Recreation in support of a task force to study the impacts of shadows on the city's parks and open spaces (Thomas 2015). He argued that as the city seeks to increase density through rezonings and higher buildings, "keeping these neighborhood green spaces clean, well-maintained, and abundant with sunshine will be even more important as they serve an ever-larger number of local residents" (Ibid., pg. 3). This sentiment was reflected in several bills introduced to the city council directly addressing the impact of shadows on parkland (Levine, Kallos and Rosenthal 2018).

Another local organization, The Municipal Art Society of New York City (MAS) frequently advocates for concerns of shadow impacts from developments and rezoning projects. One such case was the Greater East Midtown Rezoning in 2017, which revealed in its draft EIS incremental shadow impacts on Greenacre Park: a .14-acre pocket park, historical site, and one of very few public open spaces in East Midtown (Figure 11) (Goldstein 2017). The rezoning was eventually passed with specific provisions for the Greenacre Foundation, the organization responsible for overseeing the park, including that they review any zoning actions and are included in conversations with applicants and the Department of City Planning to discuss potential shadow impacts of any activities (Krisel 2017).



Figure 11: Greenacre Park in Midtown, Manhattan, New York City (Heins 2017)

Inspired by the advocacy effort to protect Greenacre Park, MAS and NY4P collaborated to create “Fight for Light” in 2019, a broader advocacy campaign to address public concerns over the lack of parks protection from building shadow (MASNYC n.d.). Over the following years, the campaign continued to advocate for parks protection and published numerous policy briefs detailing alternative policy frameworks for a city “built for sunlight” (MASNYC n.d.; Albonesi et. al. 2021). Most recently, their advocacy focused on a proposed development in Crown Heights, Brooklyn, which threatened to overshadow the Brooklyn Botanical Garden and Jackie Robinson Playground. The proposed development was officially rejected by the City Planning Commission in 2021 (MASNYC n.d.).

While smaller pocket parks tend to be of the highest concern for building shadows, tension has also grown between Central Park and the supertall towers growing to its south (Bui and White 2016; NYC Parks 2025). These towers are tall and slim which creates a shadow that is far reaching but moves quickly (the shadow of a roughly 1,000-foot tower is expected to

move at a rate of up to 3.5 feet per minute) (Ibid.). Critics of these towers resent their catering to ultra-rich absentee owners which creates empty towers of unaffordable housing units (Barr 2018). Even though the design of these towers can mitigate their shadow impact, MAS planners assert that their creation speaks to a continued “lack of intentionality” in New York City’s growth (Bui and White 2016). A New York City architecture blog argues that a plan to reduce housing costs in the city should focus on the areas where housing is needed, and supertalls need not be vilified or even considered as part of this problem at all (Barr 2018).

Summary

New York City’s CEQR process incorporates detailed assessment and consideration of building shadows and their impacts on parks and other sunlight-sensitive resources into the planning and development process. This process provides transparency in the land-use planning process and encourages informed development that considers and mitigates its impact to allow the city to continue growing while protecting vital community resources from being overshadowed. With increasingly vertical development creating growth and density, identifying and mitigating the impact of shadows on the city’s parks continues to be essential for New York to maintain the utility and vitality of its green open spaces in a growing city.

San Francisco, California

“With its dramatic physical setting comprised of hilltops and mountains, surrounded by the bay and ocean, with nature woven through the landscape, San Francisco has an intrinsic connection with its environment” (City of San Francisco 2023, 1). The San Francisco Recreation and Parks Department (RPD) manages over 3,400 acres of recreational and open space in the city including the iconic and historic Golden Gate Park and Coit Tower, over 230 neighborhood parks, and hundreds of other play areas, sports courts, recreation centers, athletic fields, and pools (Figure 12) (City of San Francisco n.d.b.). The city also contains 250 acres of state-owned and 1,600 acres of federally owned open space, making 20% of the city’s land area composed of publicly owned open space and giving it one of the top five highest ratios of parkland per resident among U.S. cities (City of San Francisco 2023). In 2017, San Francisco became the first U.S. city to provide a park within a 10-minute walk for all residents (City of

San Francisco n.d.b.). But there was a time when rapid urban growth threatened to overshadow the city’s commitment to its parklands.



Existing Open Space

- **SFRPD Land in San Francisco City Limits: 3,433 acres**
- **State-Owned Land: 255 acres**
Candlestick, Mount Sutro
- **Federal-Owned Land:**
Ocean Beach, Fort Funston, Fort Mason, Lands End, Sutro Heights, China Beach: **642 acres**
Presidio: **1000 acres**
- **Other: 560 acres**
Campuses, pilot program schoolyards, SFPUC lands, SFRA parks, SF Port parks, linear open spaces such as boulevards and parkways, and privately owned, publicly accessible open spaces in the Downtown.



NOTE: The map is to be used for reference purposes only. For parcel specific details, please refer to adopted area plans: The 2019 Central Waterfront-Dogpatch Public Realm Plan conducted an updated inventory of parks and open spaces within a quarter mile of the Central Waterfront Plan Area.

Figure 12: Map of Existing Open Space Resources from the Recreation and Open Space Element of the San Francisco General Plan (City of San Francisco 2023).

Policy Background

The proliferating construction of high-rise office buildings in San Francisco in the 1980s, allowed by the city's incentive zoning from the 1960s, raised concerns over growth that threatened the city's "unique visual character" (Lewis 1987). Residents worried that increased vertical growth would alter the city's skyline to add more shadow, create narrow streets, and increase wind speeds and traffic congestion; in short, "[San Franciscans] saw themselves as being 'Manhattanized'" (Ibid. 3). In 1985, the city adopted a new downtown plan that mandated legislative rules including fees per square foot for office space development, open space requirements, and wind and shadow study requirements for major projects to restrict growth to preserve structures that hold significant historic, architectural or contextual value to the city (Ibid.).

Five months prior to the downtown plan's adoption, because of growing concern about shadow impacts on open space and "unusually cool summer weather" in 1984, San Francisco voters passed Proposition K, then "the most stringent regulations on sunlight and shadow in the country" (City of San Francisco n.d.a; Walsh 1991, pg. 18). This proposition prohibited any building over 40 feet which would cause substantial shading of property and open space resources under the jurisdiction of the RPD (City of San Francisco 2011). A joint study conducted at the time of implementation by the RPD and the City of San Francisco Planning Commission (Planning Commission) found 70 parks with the potential for nearby development exceeding 40 feet and concluded that only three could tolerate additional shadows – the rest would be under no-new-shadow requirements (Walsh 1991).

Proposition K, Section 295, the Sunlight Ordinance

Proposition K was officially codified in Section 295 of the city's Planning Code, "Height Restrictions on Structures Shadowing Property Under the Jurisdiction of the Recreation and Park Commission" – commonly referred to as the "Sunlight Ordinance" (City of San Francisco 2015; Walsh 1991). Under the Sunlight Ordinance, any project over 40 feet and with the potential to cast a shadow for longer than the first hour after sunrise or the last before sunset requires a hearing and permit from the Planning Commission (City of San Francisco 2015). The Planning Commission (a seven-member policy body of mayoral appointees) makes their

determination of significant impact only after hearing a review and recommendation on the proposed project from the Recreation and Park Commission (Rec Commission) (Golan and Townes 2024). The main goal of this Planning Code section is to protect natural light in parks to preserve their integrity and that of the activities within (City of San Francisco 2015). This policy focuses primarily on the potential impact of shadows from new development to diminish parks' usability and utility for park goers.

When a development triggers review under the Sunlight Ordinance, the project developer must prepare a shadow study to evaluate the proposed project's shadow impact on parkland. The potential for a project to cast new shadow over a park is determined by a preliminary shadow fan, a diagram showing the maximum extent of the shadows cast by a building throughout the year, prepared as part of the Preliminary Project Assessment Process (similar to those used in New York City, see Figure 10) (Schuett and Guy 2014).

A shadow analysis is also triggered by state discretionary actions already subject to review under the California Environmental Quality Act (CEQA) (an incorporation of NEPA, similar to New York City's SEQRA Act) that would cast a shadow with potential for a negative impact on a park or open space (Ibid.). Standard procedures and scoping requirements for conducting the technical analysis for the purposes of CEQA and Section 295 (the Sunlight Ordinance) review were published by San Francisco's RPD in a 2014 Memorandum which requires the analysis to include three main components: shadow diagrams, shadow calculations, and a technical memorandum (along with survey information in some cases) (Ibid.).

Typical analysis is done based on a June 21st to December 21st solar year that includes representative sun angles from the summer to winter solstices (Schuett and Guy 2014; City of San Francisco n.d.a). Findings from this analysis describe qualitatively the building's potential new shadow and impact in terms of its time of day and year, size, duration, location of both the structure and its shadow, and the public good served by the shadow caster (City of San Francisco n.d.a).

Quantitatively, new shadow is calculated as a percentage of the park's Theoretical Annual Available Sunlight (TAAS), a measure of square-foot-hours of shadow for a park over a

period of one year (a square-foot hour of sunshine means a square foot of space in a park is in sunshine for one hour) (Golan and Townes 2024; City of San Francisco n.d.a). In a public hearing, the Rec Commission then hears an overview of the project and shadow study findings from an RPD planner and receives public comment. The Rec Commission then votes to determine whether the potential shadow poses a significant adverse impact on the use of the park in question and gives a final recommendation to the Planning Commission who takes this into account in their final approval (Golan and Townes 2024).

A 1989 Memorandum (1989 Memo) describes the quantitative and qualitative criteria by which the RPD reviews a project's shadow study and on which the Rec Commission's recommendation is based (City of San Francisco n.d.a). Quantitative measurements are taken using square-foot-hours of sunshine (Ibid.). This is multiplied by the size of the park and the total number of hours per year between one hour after sunrise and one hour before sunset (3,721 hours) to calculate the park's TAAS (Ibid.). The 1989 Memo then defines Absolute Cumulative Limits (ACLs), the additional square-foot-hours of shadow that each park can tolerate as a percentage of TAAS, and sets separate ACL standards for parks greater and less than two acres in size (Ibid.).

When comparing the existing and expected shadow conditions to identify the time of day and year that new shadow will appear, the RPD is considering the value of sunlight in the park and the impact added shadow may have on its use. Shadows should avoid park areas with existing (or future) frequent uses and where added shadow may negatively impact park vegetation; smaller shadows are generally preferable in all cases (Ibid.). Shadow duration is determined by the park's distance from the building with closer shadows moving slower and of greater concern than those far away. In their recommendation, the Rec Commission also considers the characteristics of the shadow-casting building itself. Buildings that will serve the public interest through either a "needed use" or "building design and urban form" may be looked upon more favorably and the Commission may recommend they be allocated a larger portion of the shadowed park's ACL (Ibid.).

According to the 2014 Memorandum, decisionmakers may identify these public interests along with impact fees and other public benefits in the technical memorandum submitted to the

city's Planning Department to be weighed against the shadow cast by the proposed project (Schuett and Guy 2014). On occasion, the Planning Commission may approve a project after a determination of significant park impacts from the Rec Commission if the Planning Commission determines that the benefits served by the project outweigh the known impact (Golan and Townes 2024). Project approval is ultimately a policy decision made by the Planning Commission, which must balance shadow impact along with the use the project serves and the city's broader needs (Ibid.). As such, the results of the project approval process after the Sunlight Ordinance is triggered remain a political decision that can shift with the political climate of the city government.

Implementation and Relevant Projects

One recent and notable project that triggered a shadow review under the Sunlight Ordinance was the renovation of 545 Sansome Street, part of the multi-million dollar planned investment into the Transamerica Pyramid block (Waxmann 2023). After a shadow review, the proposed construction was found to increase the shadow load on nearby Maritime Plaza by less than 1% and was given approval to proceed by the Recreation and Parks Commission and Planning Commission (Ibid.). Plans to renovate the Transamerica block began amid the Covid-19 pandemic, and RPD staff were excited by the prospect of new commercial and office space representing an inflow of investments into the city (Ibid.).

The Sunlight Ordinance has proved to be a surmountable hurdle crossed by many other projects in the city as well. Oceanwide Center, a commercial and residential tower at 50 First Street whose plans cast a shadow across four separate squares and plazas in and around Chinatown, was approved in 2016 after the developer agreed to mitigate shadows and provide a \$12 million endowment fund for local recreation and parks programming in addition to a \$40 million agreement to fund off-site affordable housing (Dineen 2016).

In 2019, the Planning Commission approved a proposed seven-story residential development in the South of Market (SoMa) neighborhood. It was to be built next to the two-acre Victoria Manalo Draves Park, the only multi-use park in the SoMa neighborhood. The neighborhood group South of Market Community Action Network (SOMCAN) appealed the decision to the Board of Supervisors (San Francisco's city council) to stop the development that

would have cast a shadow over the park. (Brinklow 2019). The Board of Supervisors upheld the appeal, stopping the project. The Supervisors' decision was heavily criticized by Mayor London Breed as a scheme against increasing the city's housing. But neighborhood members expressed overwhelmingly negative opinions of the project, commenting that it would have reinforced gentrification and was inequitable due to the neighborhood's lack of other green open space (Ibid.).

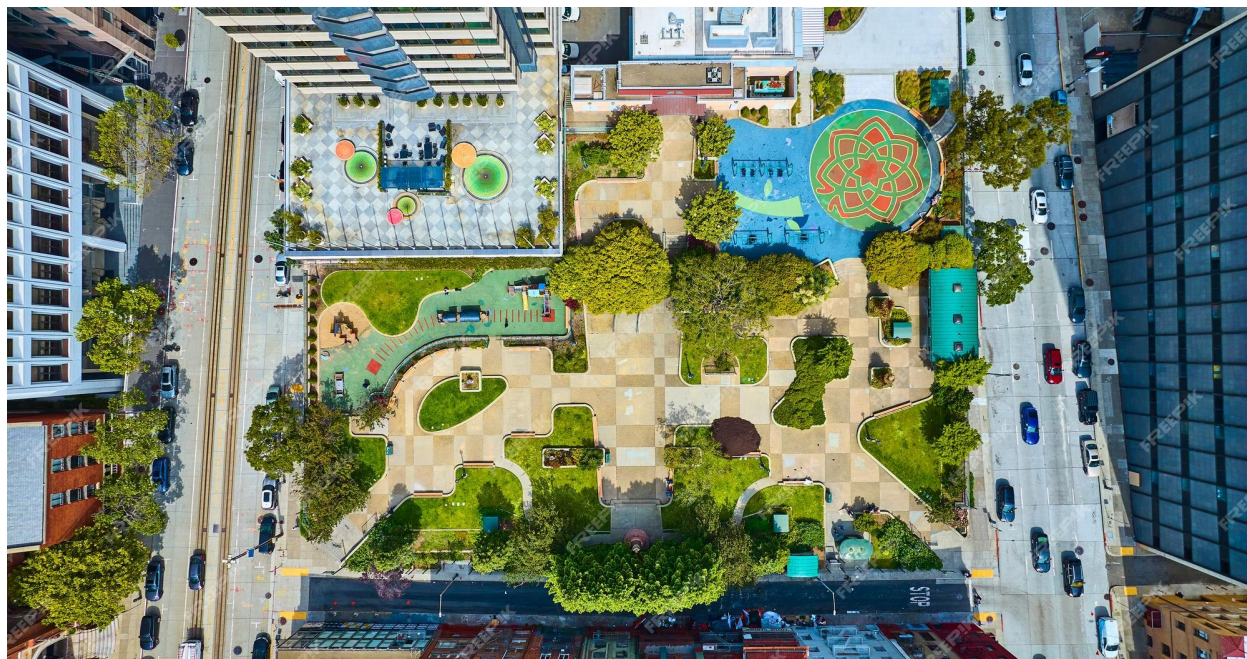


Figure 13: Aerial Photo of St. Mary's Square Park on the rooftop of 500 Pine Street. (Nick7634 2025)

As a final example, an expansion of St. Mary's Square in San Francisco's Chinatown was included in the plans for a new development's 6,000 square foot rooftop at 500 Pine Street as compensation for the shadow the building itself will cast over the rest of the park (Figure 13) (Brinklow 2017). The former buildings on the site had been demolished in preparation for two high-rises before Proposition K was passed in 1984, but after being denied an exemption from the new Sunlight Ordinance, the developer abandoned the project and left the site empty for 30 years. The new rooftop park now complements the adjacent ground-level St. Mary's Park (Ibid.) It was noted as well that despite Chinatown's dense population, it is relatively underserved by open space, and the Sunlight Ordinance review process in this case allowed for an outcome that fell strongly in favor of both the new developer and the community (Ibid.).

Summary

Spurred by a fear of overdevelopment in the 1980s, San Francisco's Sunlight Ordinance ensures the use and integrity of public open spaces by balancing the city's growth with environmental and community interests. The shadow review process, triggered by buildings over 40 feet that may cast a shadow on any property within RPD jurisdiction, is focused primarily on subjective determinations of shadow impact alongside a calculated square-foot-hour of added shadow. With a shadow analysis also comes a public hearing by the Rec Commission before their recommendation to the Planning Commission. The process can raise public concern and greatly extend the pre-development period but also opens a wide door for public comment and allows the city to leverage its open space in negotiation with developers to create new benefits for the city.

Case Studies Summary

Table 3: Comparison of New York City's and San Francisco's shadow policy and process, and application to Boston.

	New York City, NY	San Francisco, CA
Policy	City Environmental Quality Review (CEQR)	Planning Code Section 295: Sunlight Ordinance
Goal	Disclose the environmental impact of all city projects.	Protect natural light and preserve the integrity of parks and park uses.
Trigger	Any city discretionary action >50 feet tall or near sunlight-sensitive resource.	Any project >40 feet in height that would shade property under RPD jurisdiction.
Shadow Review & Analysis	CEQR Technical Manual defines sunlight-sensitive resources, describes assessment procedure and impact determination criteria. NYC Parks is consulted, and assessment is considered along with the EIS in land use approval proceedings.	Shadow assessment is reviewed by RPD, Rec Commission gives a recommendation to the Planning Commission. RPD sets ACLs for parks; 1989 Memo describes qualitative and quantitative criteria for significant impact.
Equity & Balancing	6-8 hours of sunlight is a minimum requirement. Impact on sunlight-sensitive resources is considered on a project basis, and mitigation strategies and alternatives are prepared before project approval.	Planning Commission may weigh the project's public good and public benefits against its potential shadow impact, informed by the Rec Commission's recommendation.
Key Concepts	Includes historical landmarks and natural resources. Requires thorough consideration of mitigation strategies and alternatives. Discloses environmental impacts of all city discretionary actions and complements the city's land use approval process.	Quantifies objective standards for available sunlight and acceptable sunlight loss for parks. Standalone review requirement, culminates only in a recommendation based on the shadow assessment.
Application to Boston		
<p>Massachusetts already has MEPA and Boston is currently redoing their Article 80 project review procedure. Use of 'sunlight-sensitive resources' to include historical landmarks can strengthen protections for the Emerald Necklace.</p> <p>A shadow-bank is already used for the Common, Boston could calculate ACLs and expand its use to more parks. An explicit balancing provision can allow for smart growth. A standalone policy is not streamlined and may perpetuate Boston's already complicated patchwork of guidelines and regulations for development.</p>		

These case studies reveal two different methods used by two major U.S. cities to incorporate analysis of building shadows and balance the impact of shadows with other city needs through their development approval processes. The history of these cities and implementation of their sunlight protection policies can inform how a similar policy can be tailored to Boston (Table 3).

Two avenues provide opportunities to incorporate a standardized shadow analysis method into project review in Boston. First, the Massachusetts Environmental Policy Act (MEPA), which is already used to disclose environmental impacts, could be incorporated into the city's regulations as New York City did with their CEQR. Second, the previously discussed modernization of Boston's Article 80 could incorporate a standardized shadow analysis method into project review. Recognition of sunlight-sensitive resources which expand beyond just parks can help Boston protect and value its own historic landmarks.

In San Francisco, the use of calculated ACLs provides a standardized method for measuring shadow impact and creates a structure similar to the Boston Common and Public Garden Shadow Laws, applied across the city. Shadow review in San Francisco, however, is undertaken in addition to the city's regular land use approval process which, if used in Boston, could perpetuate an already hard to navigate patchwork of regulations. The explicit inclusion of balancing provisions for the development's public good reflects San Francisco's history of incentive-based zoning and could be a way for Boston to similarly determine acceptable impacts based on the benefit of the proposed development. The following chapter further describes the Boston context by addressing the priorities of local stakeholders.

6. Interview Findings

While the above case studies describe existing sunlight protection policies in response to the first research question,

1. What are current city policies for sunlight protection in parks in the U.S.?

this Chapter addresses the second research question,

2. What elements must be addressed to develop an effective standardized policy regulating building shadows over open/green space in Boston?

through findings from interviews and field notes. (The full list of interviewees is in Table I in the Methods chapter.)

“Understanding Shadow Impacts on Parkland”

On March 27th at 6:00 pm, I arrived at Fenway Park to attend the Fenway Civic Association’s 2025 Annual Meeting. I took an elevator to the top floor and entered a conference room with windows and a balcony opening out towards the stadium. The room was beginning to fill with people wearing name tags associating themselves with a range of Fenway and Boston community organizations while others identified themselves as “dog owners” or simply neighborhood residents. On the side of the room opposite the lectern were posters from the City of Boston explaining their study-in-progress on shadow impacts on parkland and offering space for community input.

The night’s keynote presentation was “Understanding Shadow Impacts on Parkland”, given by Liza Meyer, Interim Commissioner of Boston Parks and Recreation (BPRD). This was the first public presentation providing an update on the Study of Shadow Impacts on Boston’s Parks. The study was conducted by BPRD in response to concerns about shadows and development guidelines at Longwood Place and across the city (City of Boston 2025e).

Beginning in fall of 2024, the study focuses on the Riverway and Back Bay Fens – parts of the Emerald Necklace surrounding Longwood Place. According to Meyer, the city intends to gain “a clearer understanding of a methodology that we believe will be replicable” (Meyer 2025). By knowing a landscape’s tolerance and intolerance to shadows, Boston can “evaluate

whether the new shadow that's being introduced might be more than that landscape can be expected to accommodate" and avoid negative impacts of proposed developments on existing vegetation (Meyer 2025). The results will standardize methods and metrics for understanding shadows and evaluating their impact on parklands that will eventually be used to inform policymaking. Sunlight protection policies and shadow analysis methods used in New York City, San Francisco, Toronto, and Melbourne, as well as Seattle and London were considered as precedents considered in Phase One (City of Boston 2025d).

Four current challenges to shadow impact review in Boston were identified (City of Boston 2025d):

1. Unclear, limited, and inconsistent guidelines and regulations for shadow review
2. Unclear requirements for measuring and analyzing shadows
3. Existing guidelines have no rational basis in an evaluation of thermal comfort and ecological impacts
4. Shadow impact review is in a late stage of the review process

Phase One of the study defined critical concepts including healthy ecosystems, light requirements of vegetation, risks of increasing building shadow, and differentiating between shadow (buildings) and shade (vegetation) (City of Boston 2025d). Methodologies for evaluating human use needs were created using intercept interviews and land use type classifications, and for ecological needs using field categorizations of land cover, vegetation types and other present conditions (Meyer 2025b).

To maintain healthy ecosystems in parks, the needs of soil along with groundcover and trees must be evaluated to understand the impact that additional shadow could have on allowing for adequate water and sunlight for growth and photosynthesis (Meyer 2025a). As a city that experiences four seasons, ecological needs and human use and comfort in parks vary significantly throughout the year (City of Boston 2025d). While sunlight is needed for vegetative growth in the spring and summer, sunlight is critical for human use of parks in the winter months: "If we take that away, we've made the park essentially unusable for people" (Meyer 2025a).

The study's Phase Two seeks to create a standard for analyzing shadow from proposed developments and evaluating impacts on parkland based on the metrics for shadow tolerance created in Phase One. In this exploratory stage, 3D modeling is being used to determine "what dates throughout the year are most informative for evaluating shadows" (Meyer 2025a). Meyer says that these methods will be just the beginning for policymaking: "If we can base our policy in making sure those dates are used uniformly across all projects, I think that would be a really great starting point" (2025a).

She goes on to emphasize the benefit of standardizing our understanding of shadow impacts: "If we can use the same methodology across all projects, as it relates to 'how do we understand this landscape and its needs', and define how [we] would approach that understanding, and always replicate that same methodology, [...] I think that would be beneficial" (Ibid.). Ultimately, what Meyer hopes to see "is that whatever policy or regulation we develop, we base it in [this study] that we're doing now, and we use this analysis to inform that policy" (Ibid.).

After Meyer's presentation, I caught up with Jun Seung Lee, Policy and Engagement Manager at the Emerald Necklace Conservancy (ENC), who expressed his disappointment in the progress of the study so far. I had interviewed him earlier in the week and he had recommended I attend the meeting that night. ENC's goal is to protect all parks from building shadow, and since 2022 they have been advocating for changes to the Longwood Place plans and for a comprehensive sunlight protection policy city-wide. As it turns out, much of the sentiment of the study so far about Longwood Place and its shadows been previously discovered and shared at a Fenway Civic Association community meeting two years earlier in 2023, and Jun was holding the meeting handout to prove it (see Fenway Civic Association 2023). He had told me in our interview, "I wish [a policy] could be implemented, but I think this is a good first step, and I'm hoping that it is expedited in a way, just because we do need protection now more than ever" (Lee 2025). This sense of urgency to implement park protection policies comes from the city's trend towards development in response to the perceived housing crisis, and the slow pace of policymaking in the city.

[We're] really trying to make people understand, "yes development is important, but is there a way to kind of make sure we're not steamrolling through [environmental review]?" And I think

that's been tricky because you see more development continuously happening, but a lot of these policies to protect it aren't moving as fast (Lee 2025).

The sun had set by the time I left Fenway Park that night, and I walked towards the T in the chill of early spring.

Character of Boston and The Emerald Necklace

Of particular concern to both BPRD and ENC is the design and ecological conditions of the Emerald Necklace. In the 2023 Fenway Civic Association (FCA) presentation titled “Out of the Shadows,” ENC’s Field Operations Manager, Jack Schleifer, shared the Conservancy’s ecological concerns –urban tree stress, water quality, and soil health– stemming largely from reduced temperatures caused by building shadow (Fenway Civic Association 2023). The nuances of soil science and other ecological conditions is “something that needs to be generally understood more” which can allow for more awareness of impacts by developers and informed advocacy from the public (Lee 2025). ENC has also been seeing more tree loss in the parks in recent years. They attribute these losses to developers who justify taking down trees by equating the losses to new trees they plant, “but [when] we talk to scientists or people who really care about trees, that's not the case” (Lee 2025).

This special attention to ecology is a unique aspect of the city’s current shadow study. “As far as I know,” Meyer says, “no other city is approaching it the way we are in terms of trying to understand the ecology and basing their shadow policy around what plants actually need” (2025a). While this does mean progress towards real policymaking will be slow, it ensures that Boston’s needs are uniquely reflected in policy. Even though similar studies have been conducted and policies implemented in other cities, “that's a reason not to just replicate what someone else is doing. We're actually looking at what we think is important to us” (Meyer 2025a).

As both a designated historic landmark and the city’s largest contiguous section of parkland, the Emerald Necklace warrants special consideration apart from other city parks. The Boston metropolitan area features over 60 parkways under the jurisdiction of the Massachusetts Department of Conservation and Recreation (DCR) including five that connect the Emerald Necklace parks to one another (Commonwealth of Massachusetts n.d.). To learn about how the Emerald Necklace is considered at the state level, I spoke with Ruth Helfeld,

Director of Landscape Architecture for Massachusetts DCR. Through their ownership of the Arborway, Fenway, Jamaica Way, Park Drive, and Riverway (along roads of the same names) the DCR is involved in regular conversations with Emerald Necklace stakeholders to discuss their relevant project pipeline (Helfeld 2024). The state department becomes directly involved in project review in Boston only when DCR parkland is being used for construction, access, or staging, which requires them to provide a permit (Ibid.). In these cases, DCR is able to provide comments on the design but does not make any actual changes (Ibid.). When a project is reviewed by BPRD under the Parkways Ordinance, they may also refer the project to the DCR for further review (Ibid.). DCR also contributes to park restoration work and provides support to ENC: Through a parity agreement, DCR matches ENC's investment in park maintenance annually to help support their work on the ground (Ibid.).

According to Helfeld, shadows show up often as a point of concern to DCR in project design: "Even if we don't have a regulatory authority to affect it, we certainly do look at that" (Ibid.). Since DCR's park planning mainly looks horizontally at vegetation and recreational infrastructure, they are always concerned about sunlight availability and the impact of surrounding buildings on the layout of open space (Ibid.). Safety is also a primary concern. Reduced temperature from shadows promotes ice on walking paths which is difficult to move and can make the area more dangerous (Ibid.). Additionally, an area darkened by shadows can be "hard to surveil," and might "feel unsafe" for park goers (Ibid.).

ENC also regularly involves itself in project review committees and impact advisory groups where they put a strong emphasis on park access, user experience, and historical aspects and characteristics, especially trying to uphold Olmsted's vision for the Emerald Necklace (Lee 2025). Lee explained that neighborhoods around the Emerald Necklace have been seeing proposed designs that don't represent that neighborhood. He would like to see more developers "really take time to learn what the community they're going to be in is really like," including the current and historical characteristics of the neighborhood and the community (Lee 2025). "We have this historic landscape that weaves through the city," says Meyer, "and that in some ways is unique to Boston" (2025). As park advocates, ENC wants "the Emerald Necklace [to be] accessible for all users and park experiences" (Lee 2025).

Lee explained that they don't want any developments to "hinder" Olmsted's intent for the parks to be a place for one "to get away from the city and not look at something that makes them remember the city" (2025). Similarly, Meyers recognized that "the intent of the design of [the Emerald Necklace] has been set and we don't want to introduce conditions that would not allow it to thrive going forward," which is why it is so important for the city to understand the landscape "from an ecological standpoint" (2025a). The city will be able to use this current analysis to prepare for uncertain future conditions: "[The landscape] can adapt in terms of what species of trees are growing and thriving there, we have to adapt to climate change" (Meyer 2025a).

Implications for Policymaking

Boston's 2023-2029 Open Space and Recreation Plan projects the need for 6,000 new housing units a year leading up to 2030 "to try to address the acute housing shortage" in the city (City of Boston 2023b, 3). While housing is a priority, Boston's projected 8.7% annual growth "has the potential to widen disparities in open space distribution," and "there is a significant equity issue in the need to provide open space to serve housing – particularly affordable housing" (Ibid., 3-4). Looking towards the future of the city and its ability to service residents through both housing and open space resources, the ability to protect certain resources and balance their benefits and impacts will be critical to growth. Lee hopes that people understand that "it's not just the parks that are going to be in shadow," and that growth and development will have implications for neighborhoods throughout the Emerald Necklace and across the city, not just in the Back Bay and Riverway (2025). Policy makers should ask themselves, "how can we really put in a policy so that neighborhoods aren't always going to be concerned about 'Is my sky and sunlight going to be taken?'" (Ibid.).

In future policy, he'd like to see that "it's not just the park status [being] protected but also thinking about the surrounding neighborhood and how they would also be impacted" (Ibid.). Protections for historic landmarks and architecture, Lee noted, is something that shows up in New York City's shadow review and he would like to see similar weight given to sunlight on these resources in the Emerald Necklace and Boston as well (Ibid.).

Meyer says that the results of the ongoing shadow study will put the city in a good position to balance park needs while continuing to be a growing city by allowing them to “make decisions from a point of being well informed” (2025a).

If what we find is that actually adding that hour of shadow isn't really going to have any detrimental impact, because the everything that's growing there can thrive under [fewer] hours of sunlight a day, so having that one hour isn't really going to matter, then that's good to know (Meyer 2025a).

While this study will determine ecologically tolerable amounts of shade, project review will fold in human factors as well. Meyer explained,

On the flip side, because we're also looking at this from a thermal comfort perspective, we're trying to build in that human experience. So just because the landscape might be able to tolerate a bit more shadow doesn't mean that it won't have an adverse effect on the use and experience in the park (2025a).

When asked about how future policy can balance park accessibility with necessary development for a growing population, Meyer had this to say:

The goal is to not put one against the other and to try to have both, right? [...] We're always looking to see where we can expand uses in existing parks and make the most out of what we have. And then, where we have opportunities to expand the park system, to act on those opportunities, while also supporting the need to build more housing (2025a).

Adapting parks to new conditions in a growing city, including new shadows, is a challenge that DCR handles as well. This includes considering where to place vegetation with different sunlight needs, and how to design using materials that will tolerate temperature changes from shadows. Ensuring that the grading quickly sheds water and using porous pavement to avoid heavy icing on paths are some of the ways the issue can be dealt with by planners (Ibid.). Considering the placement of park amenities, vegetation, and lighting, also can act to maintain the park's uses and avoid some negative impacts of shadows.

In some places, DCR is seeking to provide more targeted and human-scale shade in parks through their Project Shade, which provides design guidelines for tree planting and shade shelters to create comfortable outdoor spaces and mitigate the inequitable impacts of extreme urban heat (Ibid.; see Stantec 2024). In the end, some shadows will be necessary as Boston

“want[s] to be a growing city. That's why we all live here is because we're a growing thriving city as [opposed to] one that's shrinking and declining” (Meyer 2025a).

A New Development Review Process

Once the study provides tools to define the sunlight needs of park landscapes, Meyer says the tricky part will be translating this into policy to determine what projects get to consume allowable shadow (Ibid.). Policy makers will have to respond to such dilemmas as whether the first development proposed can consume as much shadow as permitted, or whether they will use a more incremental approach by limiting each development to a portion of the allowable shadow (as done in the Boston Common and Public Garden) (Meyer 2025a).

As discussed in the Background chapter, Boston is currently updating Article 80 which defines its project review process, an indicator to Lee that “there seems to be something missing” (2025). In the new modernized review process, Lee would like to see the developers do their due diligence to understand the neighborhood and incorporate the community in their designs “way before it comes to the BPDA and the Planning Department” (Ibid.). In his experience, many developers use ways “to go around different exemptions and zoning decisions that are in place” when the community “should have been in the conversation way ahead of time” (Ibid.). “You shouldn't come to the public when the design [doesn't reflect community needs] because you're going to get a lot of pushback. [...] I think that shows me you didn't really talk to the community” (Ibid.).

To combat this, ENC wants the new policy to be something “strong” that “cannot be exempted” to avoid the many loopholes and relief that developers have found and used (Ibid.). The first step, according to Lee, will be to find “a way to bring the Boston Common [and Public Garden] legislation to the Emerald Necklace,” to appreciate its unique historic, ecological, and human use values, “and slowly work our way to a more agreeable shadow policy for all parks” (Ibid.).

Another path that has yet to be pursued is a larger group advocacy effort. Issues are very site specific which lays the burden of advocacy heavily on individual parks organizations. Additionally, communication and group advocacy among and between Boston parks

organizations have not been as active since the pandemic, but shadow legislation may be an opportunity for them to “come together and advocate for policy” (Ibid.). “There’s strength in numbers and I don’t think [ENC] can do this alone at the moment,” says Lee (2025). As the city’s study is being completed, now may be the right time to start pushing for policymakers to extend “the same kind of energy and respect” given to the Common and Public Garden, to the Emerald Necklace and the rest of Boston’s parks (Ibid.).

7. Application to Boston Parks

Regulatory Mechanisms

Both New York City and San Francisco's sunlight protection policies offer unique approaches to preserving sunlight in their public parks and open space resources that can be used to inform policymaking in Boston (Table 3). While San Francisco's Sunlight Ordinance is embedded into its Planning Code and specifically requires shadow analysis and consideration of impact on top of the development process, New York City's CEQR considers shadows in its comprehensive review of environmental impacts. The existing patchwork of ordinances and regulations guiding development in Boston (Article 80, Parkways Ordinance, and local interim guidelines) already concerns park advocates and complicates the development process, and the situation may become further convoluted by an additional review requirement. Incorporating shadow review requirements and guidelines into a comprehensive review of a proposed development or environmental impacts would allow stakeholders in Boston, both developers and community members, to look to the same place for the "what" and "when" of shadow analyses and review.

Although shadow is considered in Boston's current regulatory scheme, park advocates would like to see a greater inclusion of community input, including shadow concerns, reflected in proposals at the outset, not just when development proposals receive pushback. This need may also lend itself best to the inclusion of standardized shadow guidance in a single and comprehensive development or environmental review procedure that is accessible to developers and the public. The expanded definition of sunlight-sensitive resources used in New York City to include historic architecture and landmarks is something ENC specifically would like to see incorporated into Boston. This would allow more value to be placed on non-vegetative but equally important historic structures such as bridges, gateways, and other buildings in and around the Emerald Necklace that are part of Olmsted's vision and aesthetic design.

In San Francisco, the use of quantifiable Total Annual Available Sunlight (TAAS) and absolute cumulative limits (ACLs) for specific parks is reflective of the Shadow Bank used by the

existing Boston Common and Public Garden Shadow Laws. Expanding these quantifiable limits on building shadow across the Emerald Necklace and the rest of Boston's parks would be a massive undertaking and something the city has already begun with the previously discussed study of shadow impacts on parkland. Though it would take a long time, these limits, calculated with knowledge of each park's land cover and uses, would standardize how shadows are considered for each park across the city. This would provide the city with a more objective basis for reviewing projects that is informed by an in-depth understanding of the parks. A comprehensive understanding of sunlight needs for Boston's parks would also streamline the analysis required for development, which will reduce the burden on developers and make it easier to incorporate shadow impacts earlier in their design process.

Balancing and Equity

In both U.S. cases, as in Boston, communities and their respective parks and recreation departments are seeking to preserve and enhance their parks' health and use. Though NYC Parks *should* be consulted in New York City, and the Rec Commission's recommendation is *considered* in San Francisco, final approvals in both cases are given by the cities' respective planning commissions. However, this decision can be guided by provisions that direct whether and how impacts and benefits are to be balanced. In San Francisco, how to approach this balancing is written out explicitly in the Sunlight Ordinance, which can assist the Planning Commission in justifying its decision to prioritize either a park or a "needed use" over one another. This makes guidelines for decision making, especially when there is room for subjectivity, clear to all those involved in the development process, including the community (who should stand to benefit if the public good is prioritized over impacts to a park). The process in New York City ensures that all impacts of the project are disclosed to the public, which has allowed organizations such as MAS to respond to concerns of negative impacts on parks, but does not necessarily require any justification for the city's final decision. Standardization and clarity are highly valued by all stakeholders in Boston which can be provided by including a decision-making guide built into the regulations, along with the public hearings and comment periods already in standard use.

Taking inspiration from outside the U.S., both Melbourne and Toronto's shadow studies put a high premium on thermal comfort and accessibility of parks in the wintertime. This focuses on providing access to the cooling effect of shade in the summer and the warming effect of the sun in the winter. As Boston experiences the range of seasons throughout the year, these considerations, which are already being included in the city's study, will be critical to maintaining and enhancing the accessibility of parks and their uses.

Mitigation and Adaptation

The true impact of shadows is determined by both the design of a proposed development and the makeup of the shadowed open space. As parks are already adapting to new conditions caused by climate change, it can also become necessary to adapt parks to additional shadow to mitigate the impact on vegetation and uses. Considering how to rearrange sunlight-sensitive resources in a park to preserve their value under new conditions is required by New York City's CEQR process, and Massachusetts DCR is also looking to adapt parks to new climate conditions. Although this would likely receive pushback from park advocates, it creates an opportunity to include public input and priorities in the design of open spaces and further considerations for balancing the development with its impacts. These policies provide a toolkit for how to approach sunlight protection in parks, which Boston will need to consider as it translates its study of shadow impacts into policy.

8. Conclusion

Policy Recommendations

This thesis has considered urban parks and the use of policies to regulate building shadow and protect sunlight in parks. Taking inspiration from the case studies and literature and guided by interviews and discussion of the Boston context, I have compiled five policy recommendations to inform the implementation of a sunlight protection policy in Boston.

1. Land use decisions must be based on an understanding of what's on the ground in parks.

As discussed in the Interview Findings chapter, the current and ongoing study by BPRD will result in a methodology for understanding what's on the ground in parks which will inform development and policy decisions. This will include an understanding of local vegetation and ecosystems, historical value and landmark features, recreation amenities and uses, park access, and overall thermal comfort year-round. Once the methodology for this park evaluation has been determined and standardized by the current study, funding should be secured as soon as possible to expand the study to other parks. Since the study focuses on standardization and replicability, it will be an easier task to repeat and expand it into a public city-wide park database. The publicly available database of each park's current conditions across the city should also take note of any community organizations that regularly operate within the park or rely on it for certain events. This information will allow developers to design with this knowledge from the start, and with better information available to developers, city departments, and the community, issues can be anticipated and arbitrated or avoided more efficiently.

2. BPRD should set absolute cumulative limits (ACLs) for shadow in each park and open space resource to guarantee that sunlight is maintained.

The database of current park conditions should inform BPRD's establishment of ACLs for each park or park segment like those used in San Francisco. These ACLs should consider the park's current conditions to realize its minimum sunlight requirements and set a maximum tolerable amount of shadow in acre-hours.

Similar to New York City's impact mitigation strategies, which include relocating sunlight-sensitive features within a park, BPRD should also include for each park preliminary considerations of their adaptability in terms of the feasibility of park features to be rearranged to tolerate more shadow. For example, parks in the Emerald Necklace would be designated as less adaptable since their designs represent an historic and valuable feature. A smaller park with more recreational amenities might be designated as more adaptable if it could be redesigned to place vegetative features that require sunlight into sunny areas and move features whose use is less dependent on sunlight, such as basketball or tennis courts, into areas that may be shaded more often. These recreational uses might even benefit from more shade.

These determinations would require value judgements as to the importance of the park's design and the ease of physically moving or re-creating features. ACLs and adaptability determinations should be made by BPRD as soon as possible to ensure that they precede and are impartial from any specific development proposal. Since shadow studies are already required of developers as part of the Article 80 project review process, this information would be very time-sensitive, and its early availability would lead to better informed proposals.

3. The Parks and Recreation Commission should be the only authority to relax minimum sunlight requirements for developers.

The City of Boston should codify adherence to the established ACLs in their Zoning Ordinance and establish the Parks and Recreation Commission (Parks Commission) as the only authority to relax the ACL requirements. Projects will know if they must comply with any park ACLs after completing an initial shadow analysis as required by Article 80. ACLs should only be relaxed if BPRD and the Parks Commission determines that the park features can be easily adapted to accommodate more shadow with minimal impact on its vegetation, use, and enjoyment, and the developer is willing to provide the funding and potentially the expertise to do so.

The bargaining process between developers and the city, examples of which have been cited in Boston and San Francisco, can provide the city with new improvement resources. This process would look similar to the Boston Common and Public Garden Shadow Laws through which the city can allow a project that violates the law to draw from a shadow bank and be

exempted. Requiring the Parks Commission be the authority in allowing projects to exceed ACLs, makes them a direct actor in the bargaining process which will ensure stronger protection for historic parks. It ensures that all projects are a net benefit for Boston's parks and open space resources, which is a benefit to the city as a whole. With this authority, BPRD and the Parks Commission should establish a public hearing and community engagement process that allows the city and the developer to look deeper into the park's adaptability and prepare potential park adaptation plans that addresses current public needs and input. The developer funds for parks can support capital improvements and will be critical to adapting Boston's open spaces to mitigate the impact of climate change and maintain their use and accessibility, as noted in the Mitigation and Adaptation section of the Application to Boston Parks chapter.

One issue that may arise from establishing ACLs is the possibility that the first proposed project would opportunistically consume all allowable shadow for a given park. For this reason, BPRD should establish a shadow allowance in acre-hours for individual projects. Individual project allowances would be calculated based on a proportion of available sunlight and the proposed bulk of the development. This ratio may need to be different for each park and would need to be fairly low, especially for smaller parks. With this information about the park and its ACL available to the public as soon as possible, developers will be able to design with these considerations in mind.

4. *Sunlight protection for parks should be incorporated into a comprehensive environmental review policy and process to streamline and provide clarity on the required analyses and disclosure of impacts.*

New York City's CEQR process as a comprehensive review that includes shadows versus San Francisco's Sunlight Ordinance's standalone shadow analysis requirement, is the largest structural difference between the two case study policies. As previously discussed in the Regulatory Mechanisms section of the Application to Boston Parks chapter, Boston's shadow analysis requirements should be consolidated into a single policy, and that policy should be part of a comprehensive project review of environmental impacts. A comprehensive environmental review with consideration of shadows is already required by Boston's Article 80. Since this process is currently undergoing an update which has included public comment, it can be assumed that the resulting project review process will be well understood and supported by

relevant stakeholders (City of Boston n.d.c.). Consolidating the trigger for shadow review into this process will mean developers are well aware of its requirements. Once existing conditions information is available and ACLs are set for each park, developers will know early whether their site and design raises shadow concerns as they proceed through Article 80 review and will use this knowledge to design and engage with the community. City departments and parks organizations will also have an easier time identifying concerns with future projects as they will be explicitly disclosed during the initial project review instead of requiring advocacy to solicit shadow analysis.

5. *A sunlight protection policy should create an expanded definition of “sunlight-sensitive resources” to properly value Boston’s historic open space resources along with its parks.*

Acknowledging and incorporating the value of historically significant landmarks such as houses, bridges, gates and other structures around the Emerald Necklace and Boston is important to both the city and park organizations (as addressed in the Interview Findings chapter and further discussed in the Application to Boston Parks chapter). These resources contribute to Boston parks’ aesthetic value and walkability and retain the city’s overall historic significance. The sunlight sensitivity of these resources should be given the same consideration as parks, as done in New York City. Article 80’s consideration of an expanded definition for sunlight-sensitive resources could grant authority to Boston’s Landmarks Commission and the Office of Historic Preservation to set ACLs for resources under their jurisdiction and bargain with developers in the same manner as the Parks Commission would. To do this, the Office of Historic Preservation would have to address any unique considerations for landmarks and historic architecture not already considered by BPRD’s study of shadow impacts. Although this may be a burden to the department, it would guarantee protection for Boston’s most valuable sites as the city continues to grow.

Limitations and Future Research

Although this thesis was limited to the academic year, future studies should incorporate more sunlight protection policies, both within and outside the United States to gather more existing research and precedents. The effectiveness of these policies can also be evaluated and compared to one another to establish a greater understanding of how well these policies really

work in practice. This should include interviewing more planners in each of these cities as well as conversations with more representatives of local parks users, stewardship organizations, and developers. Addressing sunlight protection policies outside the United States was beyond the scope of this thesis as the structure of their planning schemes is less comparable to that of the U.S., and this would be an important direction for future studies. Gaps in literature were also identified regarding the 3D analysis of land cover and urban heat, and the economic value of sunlight in cities and parks. The technical methodology for shadow analysis is also an important direction for future research. These measurements, which are used by cities and developers to calculate the location and times of shadows that a proposed development will produce, are not currently standardized.

Conclusion

Public parks and open spaces are extremely valuable for their vast ecosystem services and the opportunity for outdoor relaxation and recreation that they provide. These benefits are especially true in urban environments due to their ability to combat the negative environmental effects of urbanization. This can be seen through their ecosystem benefits, including their cooling effect on ambient air temperature, sequestration of air and water pollutants, and stormwater management, as well as being in physical and psychological contrast from the city. These values were held in high regard by Frederick Law Olmsted when designing the now historic Emerald Necklace to be widely accessible natural respite from the city and intentionally improve both urban sanitation and public health.

While shade provided by vegetation offers year-round thermal comfort and is conducive to plant growth, shadow from buildings can negatively impact both park vegetation and park users. This is because building shadow reduces air and ground temperature without allowing any sunlight penetration or seasonal change. The threat of new developments overshadowing pre-existing resources, including parks, is as old as cities themselves, and it has been formally addressed by governments as far back as 1600s English property law. Protecting and preserving sunlight in parks and open space resources became a concern to cities in the United States including Boston, New York City, and San Francisco through the 20th century to today. This thesis studied how New York City and San Francisco have created sunlight protection policies

to regulate the ability for new developments to add shadow to their parks. New York City addresses shadows on parks through their CEQR process undergone for all development projects. San Francisco addresses shadows through the Sunlight Ordinance, a section of the planning code which outlines conditions which trigger a shadow analysis and criteria for evaluation shadows in addition to their regular project review process.

Boston's Common and Public Garden were afforded protection through their respective shadow laws in the 1990s after a large advocacy push from parks organizations. Advocacy for a similar policy to be expanded to the Emerald Necklace and the rest of the city's parks has arisen in recent years. Currently, protections for the Emerald Necklace include the Parkways Ordinance that buffers the parks from development and a patchwork of interim development guidelines for specific planned development areas. To establish its own city-wide sunlight protection policy, Boston should use its study of shadow impacts on parkland to set informed limits on the tolerable shadow for each park as well as other historic landmarks. The city should also include the Parks and Recreation Commission in planning decisions to ensure that park interests are considered in the planning process and avoid exemptions which have become the norm. As Boston is currently conducting a study to understand the impacts of shadows on parkland that will inform policy and modernize the Article 80 project review process, now is the time to learn from existing sunlight protection policies to regulate the city's growth and secure the enjoyment of Boston's historic parks for future generations.

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