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Climate Corps

Research Project

Extreme Heat in Groton, CT: Insights from Other Cities for a Sustainable Future

Introduction

In this project, I will research how Groton is impacted by extreme heat. I will examine how its land use policies and zoning regulations either mitigate or exacerbate these risks. Global temperatures are rising due to anthropogenic climate change, which contributes to more extreme and frequent heat events. The Town of Groton, CT is already experiencing the effects of extreme heat. Residents are facing the high cost of air conditioning and seeking refuge in cool spaces. According to data from the U.S. Energy Information Administration, Connecticut ranks among the top five states for highest average residential electricity rates. This presents a financial burden for households during heatwaves, particularly for low-income and vulnerable populations. This report will investigate Groton's current vulnerabilities and other communities have implemented to adapt to extreme heat risks. I researched three municipalities and their approach towards extreme heat: Boston, MA, Chelsea, MA, and New York City, NY. I will consider their methods and weigh whether these are feasible options for Groton. My goal is to provide suggestions for the future, keeping in mind Groton's zoning policies and specific needs.

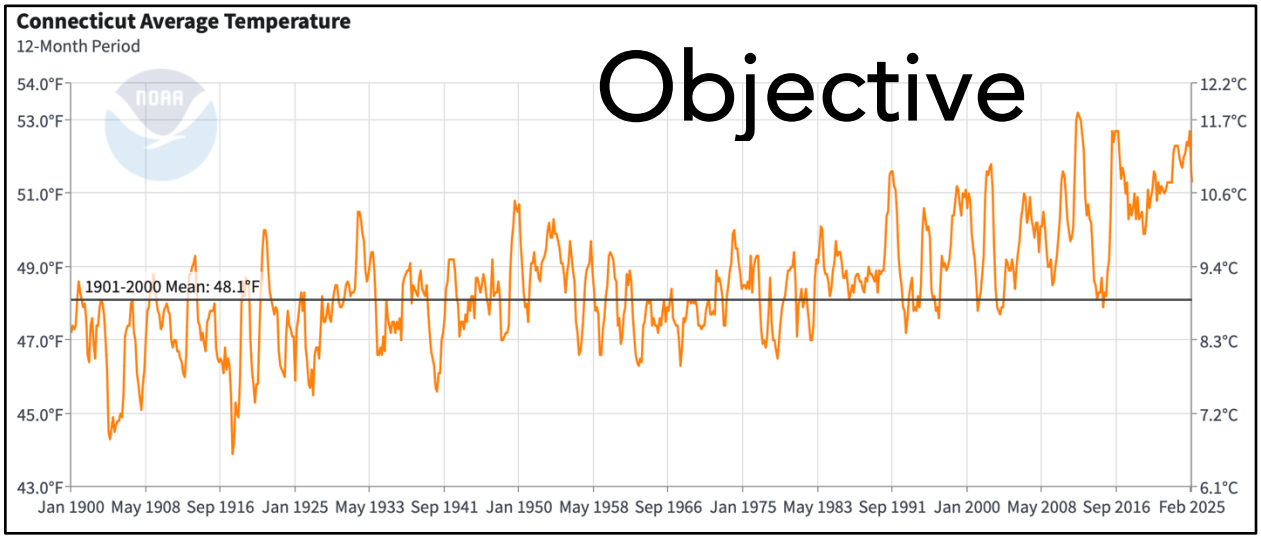
Methodology

The methodology for this study is data collection and policy research. Clare McCarthy, a sustainability fellow for the Town of Groton, previously conducted extensive research regarding extreme heat in Groton. I plan on reviewing these resources as a source of background information, allowing me to understand Groton's background and specific needs. From these

documents, I will understand climate data, energy consumption, and urban planning to understand what Groton has already done and how we can move forward. Afterward, I will research three other municipalities like Groton and how they addressed extreme heat. These three cities are Boston, MA, Chelsea, MA, and New York City, NY. Researching the different mechanisms that these coastal towns use to adapt to extreme heat will allow me to understand what worked and what didn't, and how this can be applied to Groton. Lastly, I will evaluate how Groton's climate, infrastructure, and policies compare to those of the other municipalities. I will take this into consideration when I create recommendations for the Town of Groton to have a well-rounded understanding of what will work best for this municipality.

Literature Review

Extreme heat has implications for the health of people and communities, particularly by impacting people's physical and mental health. However, these impacts do not affect everyone equally – heat is an environmental justice issue. Lower-income and minority communities are disproportionately impacted during the hotter months, for they cannot afford to justify paying for cooling systems (5). In addition, CT residents underestimate the heat risk in their region, putting them at greater risk of extreme heat.



Graph: The Statewide Time Series from NOAA (National Oceanic and Atmospheric Administration) showcasing Connecticut's average temperature from 1990 until February 2025.

Although CT is not as prone to hot weather as other regions, the state's temperatures are rising at an unpreceded rate due to anthropogenic climate change. As observed in the graph above, extreme heat is becoming more frequent and intense. According to data recorded by the National Oceanic and Atmospheric Administration (NOAA), the average annual temperature in CT has increased from 47.2°F to 51.3°F within the previous century As indicated in Figure 1, the temperature increase has been especially apparent in recent years in Groton, a trend that is only projected to increase in coming years.

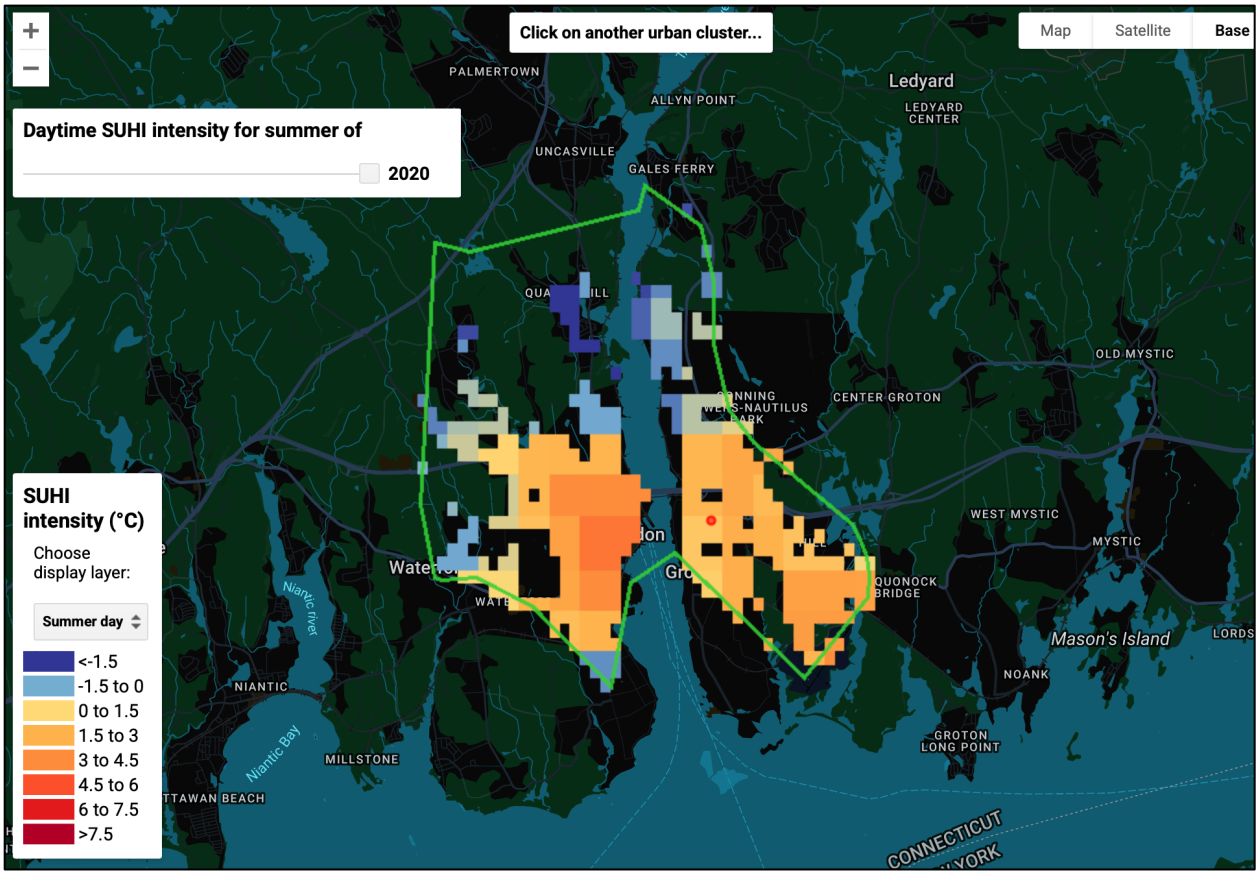


Figure 1: The Global Surface UHI Explorer is an interactive web app to monitor urban heat island (UHI) intensities. This image showcases the summer UHI intensity for the Town of Groton, CT in the year 2020.

Groton exhibits characteristics of an Urban Heat Island (UHI). This refers to a pattern where developed areas become significantly warmer than rural areas due to the heat-retaining properties of buildings, roads, and other infrastructure. According to the Global Surface UHI Explorer, parts of Groton experience surface temperatures up to 6°C warmer than less-developed areas on hot days.

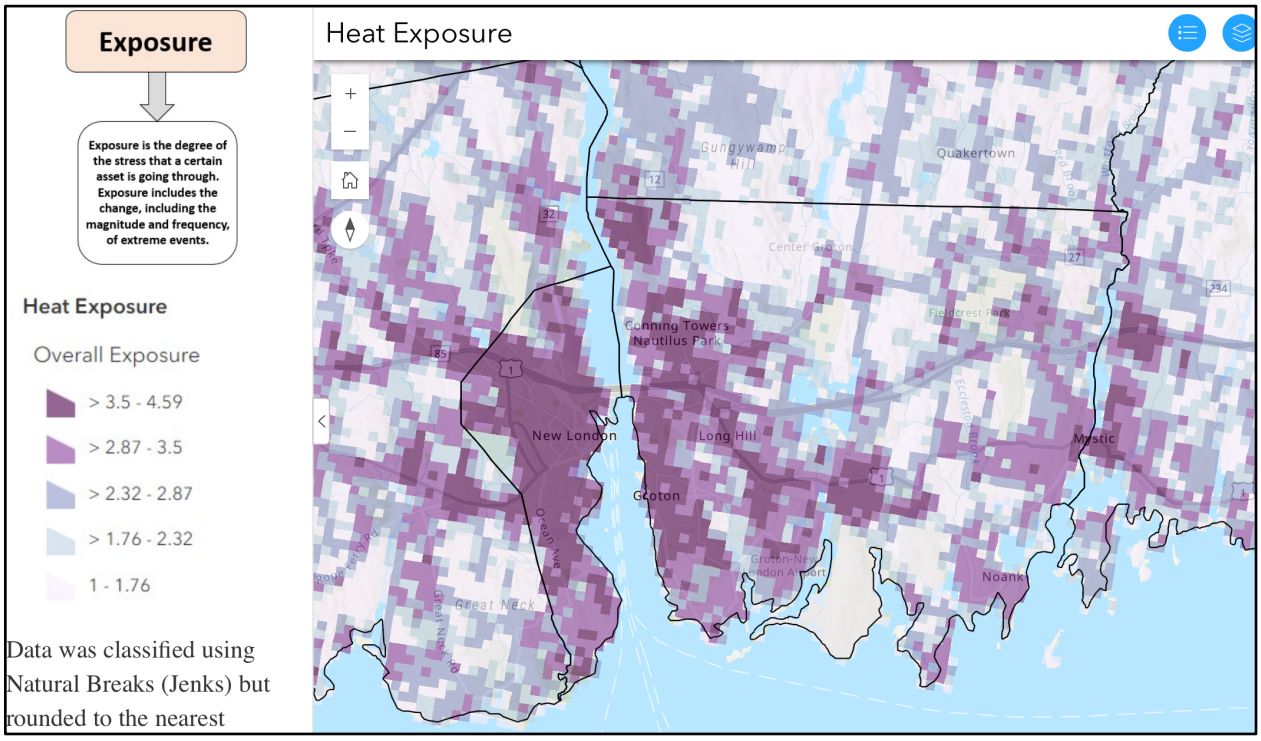


Figure 2: This map is taken from the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) under the Climate Change Vulnerability Index. This specific model isolates exposure – the frequency and intensity of extreme heat. This layer does not consider a community's ability to respond, just the physical exposure to heat itself.

Heat exposure refers to how frequently and intensely an area experiences high temperature. As shown in Figure 2, central and southern parts of Groton experience the highest levels of heat exposure. These areas are highly developed with impervious surface and limited vegetation, making them more prone to absorbing and retaining heat.

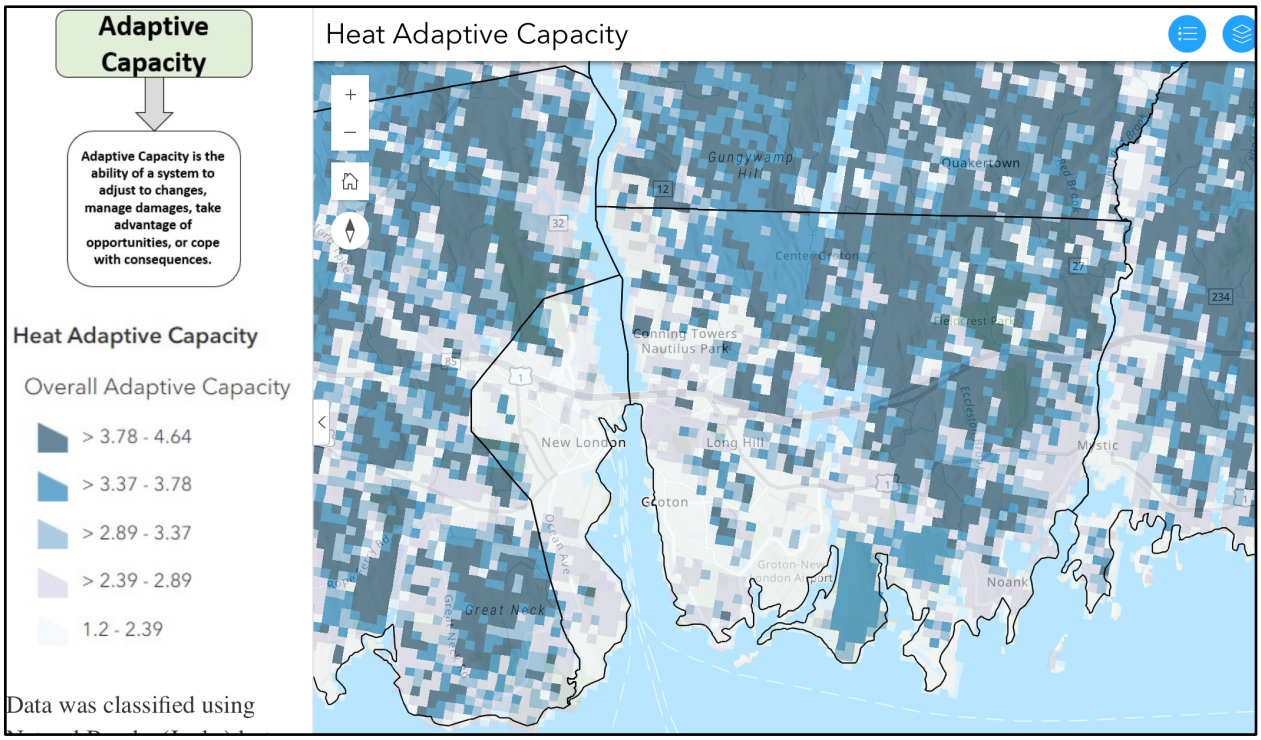


Figure 3: This map is also taken from CIRCA, but only considers adaptive capacity. This map considers how well a community can respond to and recover from heat stress.

Figure 3 shows that areas in darker blue (northwestern Groton) have a stronger capacity to adapt to extreme heat. This could be due to factors like income, access to healthcare and tree cover. Lighter areas, such as the Groton-New London Airport area, have lower capacity and may be more vulnerable to extreme heat.

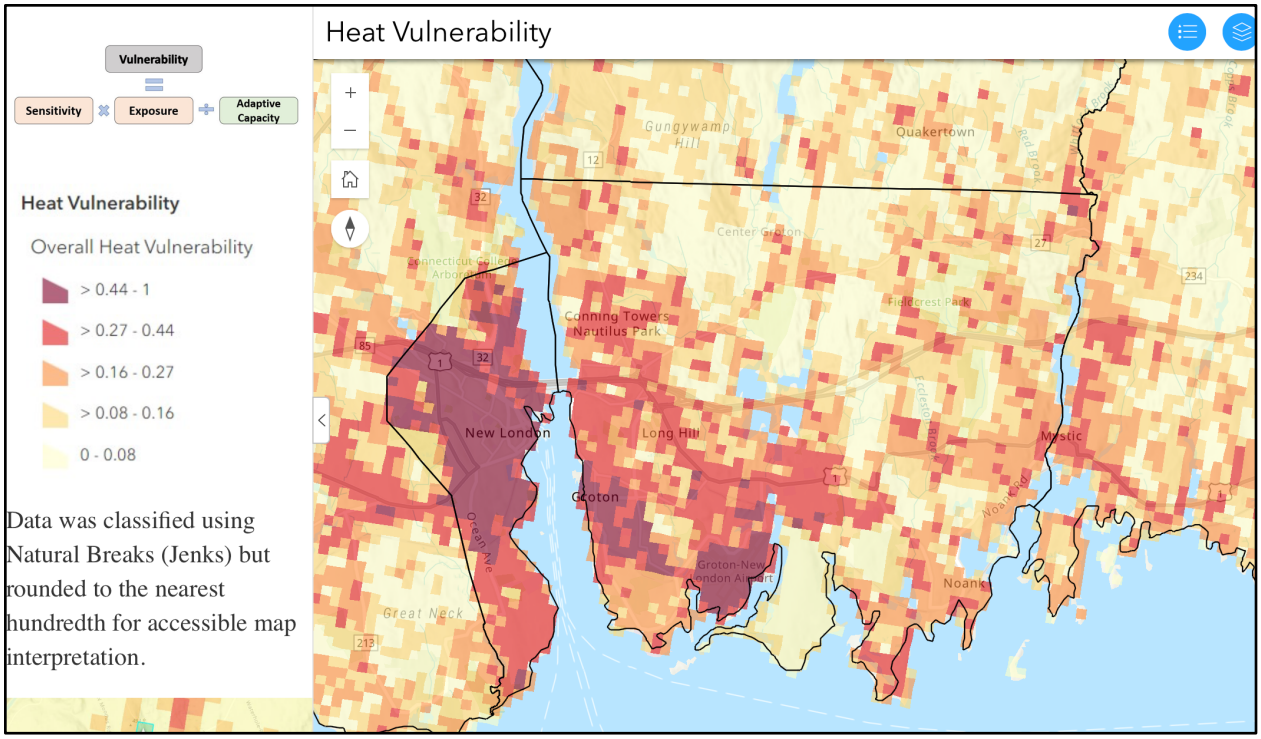


Figure 4: This map from CIRCA shows the combined heat vulnerability for Groton and surrounding areas, accounting for sensitivity, exposure, and adaptative capacity. Vulnerability is highest where exposure is high and adaptive capacity is low.

Heat vulnerability considers exposure and adaptive capacity as well demographic factors such as age, income, and housing conditions. This can be visualized in Figure 4. Darker red areas (such as Long Hill, Groton Center, and the surrounding residential neighborhoods) face the highest heat vulnerability, meaning they are more likely to suffer negative health or infrastructure impacts during extreme heat events.

There is an evident pattern – Groton's most heat-exposed areas are also among its most vulnerable. Residential zones overlap with the most vulnerable areas. These districts are often built with wide roads, minimal tree cover, and large paved surfaces – all of which increase localized heat. Without intervention, these areas are at risk for future extreme heat events.

Climate-extreme heat is a threat to human health . Heat also impacts community infrastructure, agricultural systems, and exacerbates other environmental threats. Heat-related morbidity and mortality are preventable. Communities around the world are taking action to respond to heat through mitigation and adaptation – adjusting infrastructure and social behaviors. In this report, I will explore both options. The ideal solution is a combination of mitigation and adaptation. This report focuses on communities that are coastal and located in New England. This was intentional, so that the recommendations can be better tailored for the town of Groton, CT.

Findings/Results

The city of Boston, Massachusetts, has adopted pop-up heat relief as part of its Heat Resilience Solutions initiative. These temporary installations are strategically placed in neighborhoods that experience high heat exposure, particularly those with limited access to green spaces or cooling centers. Pop-up heat relief includes shaded seating areas, hydration stations, and reflective materials designed to lower temperatures. In partnership with community organizations, the City of Boston aims to engage youth and community organizations, increase social interaction and community building, and engage local economies. Some of the benefits of these establishments are employment opportunities to support the local economy, awareness of City services, and an opportunity to celebrate culture and heritage.

Not far from Boston, the town of Chelsea, MA implemented the Cool Block Project. It began through the C-Heat program, where faculty and students from Boston University recorded temperatures in the area. They utilized high-school students working for GreenRoots (non-profit) to collect heat data. These students recorded temperatures from different parts of the community – such as parks, streets, bus stops, and more, providing a picture of the hot spots in Chelsea.

During this time, the City received a Municipal Vulnerability Planning Grant from the state. They started working together to identify ideal areas for intervention. They settled on a block of land – one of the most densely populated census tracts in the city. The plan was to integrate different methods to make the block as cool as possible – hence the name The Cool Block. Trees were planted along the streets and sections of the streets were repaved to accommodate new greenspace and stormwater drainage. They also lightened the asphalt, so it no longer absorbed and stored as much heat. They converted the empty lot into a public space, adding shade and a lighter-colored pavement. Their goal was to transform the lot into a cooling space. Overall, their priority is to maintain the community involved at every step of the process to understand what works and what doesn't work.

NYC CoolRoofs provides New Yorkers with paid training and work experience to install energy-saving reflective rooftops. This program was started in 2009 as a volunteer-based program to support NYC's efforts to combat climate change. The annual goal is to install one million square feet of rooftops while engaging local property owners, community partners, workforce training organizations and volunteers. Some of the benefits from this program is reduced roof temperatures, reduced internal building temperatures, reduced Urban Heat Island Effect, reduced carbon emissions, improved air quality, and extended lifespan of rooftops and HVAC equipment.

Discussion

Groton's zoning regulations shape how land is used, what can be built, and the characteristics of the built environment. These factors impact the Urban Heat Island (UHI) effect. In this section, I will examine and remediate the regulatory gaps that contribute to extreme heat

vulnerability. I will also consider opportunities for climate adaptation and mitigation within existing zoning regulations.

A review of the Town of Groton's zoning map and regulations reveals that a large percentage of land is zoned for residential use; particularly the R-7, R-12, RS-12, RS-20, RU-20, RU-40, and RU-80 districts. These residential districts are characterized by a low-to-medium building density, which provides both opportunities and challenges in terms of mitigating the impacts of extreme heat.

Residential zoning districts tend to be lower in density. Even so, these areas contribute to urban heat through traditional suburban design: wide paved driveways, lack of shade, and limited tree canopy requirements. Groton's Open Space Subdivisions regulations address these issues. According to Section 6.3 from the Town of Groton Zoning Regulations, at least 20% of the site must be designated as a common open space and include foundation plantings and shade trees along all trees. If these regulations are expanded beyond these subdivisions, such requirements could increase vegetative cover across the entire town. A potential solution is requiring tree canopy minimums or increased shading ratios in all residential districts, not just the open space subdivisions. Currently, there is no present enforcement mechanism for retaining existing trees or mandating cool materials for roads or roofs. The Town of Groton can remediate this by requiring at least 30% tree canopy coverage in each lot in RS and RU zones. In denser zones (R-7, R-12), where yards are smaller, the requirement can be a minimum 2 trees per lot, one of which must be planted in the front yard. Smaller lots can satisfy this requirement through shared canopy from street trees or adjacent lots. To implement this regulation, the Town can use GIS to monitor compliance and offer incentives – such as fee waivers that exceed a certain percentage of canopy.

Commercial districts (CN and CR) and mixed-use zones like the Town Center (MTC) and Village Center (MVC) allow higher building coverage (40%) and taller structures. These districts are more likely to contain impervious surfaces, large parking lots, and taller buildings – structures that trap heat. Although pedestrian access and design are regulated for aesthetics, there are no mandates around cool roofing, albedo-enhancing materials, or on-site stormwater cooling systems. One way in which the zoning plan could remediate this is by introducing incentives for cool roofs, green roofs, and permeable pavement for parking areas in commercial and mixed-use zones.

The Industrial General (IG) and Industrial Mixed-Use (IM) districts allow up to 40% building coverage. These zones disproportionately contribute to heat islands due to expansive paved surfaces, roof area, and vehicle traffic. In addition, most of these lots are characterized by impervious surfaces. Although environmental risks such as hazardous waste are heavily regulated, these are no specific provisions addressing heat islands. The zoning plan can address this is by requiring industrial projects to submit a heat mitigation plan. Some strategies that these plans could incorporate are shaded loading zones, vegetated buffers, and reflective roofing materials.

The Town of Groton contains three independent zoning districts. The following includes aspects from the City of Groton Independent Zoning area. While it is not a main priority, it is still a worthwhile mention. This has been taken from the City of Groton's Zoning Regulations. The City is a smaller portion that includes the industrial waterfront and some coastal housing, which will be mentioned in the subsequent paragraphs.

Planned Development Districts (PDD) are designed to provide flexibility, with regulatory control, to achieve targeted developmental objectives within the City of Groton. The goal of the

PDD is to diversity development opportunities by encouraging mixed-used developments. This provides Groton with the opportunity to incentivize green roofs, high-albedo surfaces, street trees and shade structures in new developments.

The Mixed-Use Development District (MUDD) is one of the "floating zones" included within the PDD. It is designed to encourage urban development in proximity to places of major employment. This design includes standards for the architectural style of buildings, linked community facilities, and signage for stormwater management. A weakness within the MUDD is a lack of incentives for structures that minimize the UHI effect – such green roofs or cool pavements.

The Recreation Open Space (ROS) is a zone intended for recreation. It includes nature trails, arboretums, playgrounds, land reserves, and other areas of natural scenic beauty. The ROS district limits building coverage to 10%, meaning that 90% of the space must remain open. This open area will likely be green, shaded, or pervious, which helps reduce heat. Many of the other districts have a higher lot coverage maximum. This is not intrinsically a negative feature, however, there is no rule that requires a certain percentage of the remaining space to be green. This leads to more buildings, asphalt, and less vegetation – thus creating "heat traps." On the positive side, the ROS zoning regulations promotes essential green space. This can help cool nearby neighborhoods, ideally those that are in low-income areas. Enhancing and expanding this zone can help mitigate heat impacts.

The Flood Protection Overlay Zone (FP) is intended to fulfill requirements for participation by the City of Groton in the National Flood Insurance Program. These regulations also aim to minimize expenditure for flood control projects, prevent increases in flood heights, and discourage development in a floodplain. Although this zone is not focused on head, the FP

places an emphasis on stormwater management, which aligns with climate resilience goals. This presents an opportunity to integrate cooling infrastructure (e.g., bioswales, shade trees) into stormwater strategies.

Conclusion

Like many coastal New England towns, Groton is increasingly vulnerable to extreme heat. Although Connecticut's historical climate did not warrant extensive heat mitigation efforts, climate trends provide evidence in favor of infrastructure and policies to combat extreme heat. Zoning regulations present both barriers and opportunities in this regard.

We can learn from what other municipalities have adopted. Boston, MA, established temporary relief centers, showcasing the importance of adaptable, people-centered design. The town of Chelsea, MA, adopted a Cool Block Project with great success, demonstrating that community efforts can make a significant difference. Similarly, New York's CoolRoofs program serves as evidence for the effectiveness of policy-supported incentive programs.

In this research, I also reviewed Groton's zoning policies and identified areas of improvement regarding heat resilience. I combined my findings with the research I conducted from the municipalities to create a well-rounded approach for the Town of Groton. Groton's zoning code provides a stable foundation for creating a climate-resilient town in the face of extreme heat. A positive element in current regulations are open space requirement and the subdivision design requiring shade trees along streets in these developments. In addition, the zoning restricts pollution or high-risk heavy industrial uses. However, Groton's zoning policies have room to improve. Currently, the plan does not acknowledge the Urban Heat Island (UHI) effect. In addition, there is no requirement for tree retention on lots outside Open Space

Subdivisions. There is also no mention of shaded public infrastructure, even in dense zones such as the Town Center (MTC).

Applying these considerations as well as approaches from the three researched municipalities, the following zoning updates are recommended for Groton. (1) Mandate tree preservation and shade tree planting in all residential and commercial districts. (2) Update materials standards to encourage reflective roofing, permeable paving, and light-colored streets. (3) Implement green or cool roof standards for all new commercial, mixed use, and industrial buildings. (4) Integrate UHI considerations into zoning considerations. (5) Use zoning incentives to encourage shared community green spaces and shaded areas in commercial centers.

A significant portion of Groton is rural, which provides natural buffers. However, densifying areas (residential zones near Mystic, Route 184, and Groton-New London Airport) will require stronger green zoning policies to adapt to a hotter future. By adjusting its zoning regulations and learning from similar communities, Groton can build resilience to extreme heat through thoughtful land-use policy.

References

1. McCarthy, Clare. “Planning for Extreme Heat in Groton, Connecticut.” *Greater Groton*, www.greatergroton.com/stay-cool-groton. Accessed 28 Mar. 2025.
2. McCarthy, Clare. “Extreme Heat and Its Impacts on the Town of Groton, CT.” *Town of Groton*. Accessed 28 Mar. 2025.
3. McCarthy, Clare. “Heat Adaptation and Mitigation in Groton: Recommended Strategies for Heat Resilience” *Town of Groton*. Accessed 28 Mar. 2025.
4. McCarthy, Clare. “Heat Response Strategies: A Summary Report to Inform the Town of Groton, Connecticut’s Heat Response” *Town of Groton*. Accessed 28 Mar. 2025.
5. Schramm, Paul J., et al. “Fifth National Climate Assessment, Chapter 15: Human Health.” *Fifth National Climate Assessment*, 14 Nov. 2023, nca2023.globalchange.gov/chapter/15/.
6. “Average Price of Electricity to Ultimate Customers by End-Use Sector.” *U.S. Energy Information Administration (EIA)*, www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a. Accessed 20 Apr. 2025.
7. “Heat Resilience Solutions for Boston.” *Boston.Gov, 1 Nov. 2024,* www.boston.gov/departments/climate-resilience/heat-resilience-solutions-boston.
8. “The Chelsea Cool Block.” *Turnaround Films*, Trillium Studios Film, https://www.turnaround-films.com/14-public-chelsea-cool-block. Accessed 3 Apr. 2025.
9. “Helping the Environment and Saving Energy.” *NYC CoolRoofs*, nyc-business.nyc.gov/nycbusiness/business-services/incentives/nyc-coolroofs. Accessed 3 Apr. 2025.

10. NCEI.Monitoring.Info@noaa.gov. “Climate at a Glance: Statewide Time Series.” *NOAA: National Centers for Environmental Information*, https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide/time-series. Accessed 5 Apr. 2025.
11. “Global Surface UHI Explorer.” *Yale Center for Geospatial Solutions*, yceo.yale.edu/research/global-surface-uhi-explorer. Accessed 7 Apr. 2025.
12. “Climate Change Vulnerability Index.” *Connecticut Institute for Resilience and Climate Adaptation*, experience.arcgis.com/experience/a364a5f4870c4dc7ba53c681543521af/. Accessed 7 Apr. 2025.
13. “Zoning Regulations.” *City of Groton: History in the Making*, www.cityofgroton.com/281/Zoning-Regulations. Accessed 12 Apr. 2025.
14. “Planning and Development: Regulations.” *Town of Groton*, www.groton-ct.gov/departments/plandev/regulations.php#outer-469. Accessed 12 Apr. 2025.
15. “Planning and Development: Maps.” *Town of Groton*, www.groton-ct.gov/departments/plandev/maps.php. Accessed 12 Apr. 2025.