Improving Thermal Comfort in Windsor, ON; Assessing Urban Parks and Playgrounds

Susan Blanchard

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Executive Summary

Climate change has become a common topic of discussion, and is responsible for the increased frequency and intensity of recent extreme weather events. Anthropogenic activities, including the increase use of fossil fuels and infrastructure development, have significantly altered the function of environmental systems, and have caused an increase in atmospheric temperature commonly known as global warming. Increased temperatures and extreme heat events have proven to be a threat to human health. The impacts of extreme heat are especially damaging to vulnerable populations living in urban areas, such as the elderly, young children, and people living in poverty. The phenomenon known as the urban heat island effect (UHIE) occurs when city temperatures are much higher than the rural surroundings. This is caused by increased urban development and the loss of vegetation seen in urban areas such as the Windsor-Essex region.

Urban heat islands can have a number of negative impacts on local populations and are more intense during summer months. Since Windsor, ON is the southernmost Canadian city, it frequently experiences high temperatures and humidity values throughout the summer. Industrial development and reduced vegetation coverage, combined with hot summer temperatures, make Windsor susceptible to the UHIE. Health issues associated with UHIE are dehydration, heat cramps, heat rash, heat exhaustion, and heat stroke. Environmental and public health impacts associated with the UHIE are enough to encourage the implementation of mitigation strategies aimed to help increase the thermal comfort in public areas.

City parks offer Windsor residents an area where they can enjoy the outdoors and maintain their physical activity. Urban parks are known to have lower temperatures compared to their surrounding environment, mainly due to the presence of vegetation. Despite this, parks are still affected by high temperatures caused by the UHIE. Extreme heat events can cause a decrease in thermal comfort levels in urban parks. This can negatively impact the health of park users, and discourage them from participating in park activities. This report aims to identify specific design factors that can influence the thermal comfort in city parks, to increase the knowledge surrounding heat resilient park design, and to provide recommendations that will support climate change adaptation in the City of Windsor, ON.

Windsor has 203 city parks. In order to effectively study heat resilient park design and thermal comfort in the area, the following steps were completed:

- A thorough literature review of recent articles regarding the UHIE and thermal comfort, and interviews with experts in the field were was done
- A total of six parks in Windsor were chosen to be assessed; two are neighbourhood parks, two are community parks, and two are regional parks
- Site assessments were completed at each park which included:
  - Observing current landscape and design features
  - Observing the local surroundings as well as what type of people are using each park
  - Completing thermal comfort and shade audits

- Distribution of a questionnaire in order to obtain public opinions on park design and thermal comfort

Combining this information helped to produce design ideas and recommendations that are not only useful for Windsor, but all Canadian cities interested in improving thermal comfort in public spaces.

Results revealed that there are number of different factors that can influence park temperatures and environmental comfort. Parks that have more vegetation and shade coverage were much cooler compared to others. Similarly, parks with water features, such as splash pads and sprinklers, attracted more park users, offering them an escape from the heat during the summer. Specific paving materials, such as asphalt, were proven to have the highest surface temperatures. All of these factors combined contribute to the level of thermal comfort seen in the six parks that were studied.

After the research was completed, recommendations aimed to help improve the thermal environment in public parks were produced. Increasing the amount of vegetation in city parks, incorporating water features, and using proper paving and building materials will undoubtedly lead to lower temperatures during the summer months. In order to gain support from local government when implementing heat resilient park design ideas, specific goals and supporting policies should be developed. Collaboration between departments and stakeholder groups is also encouraged. Most importantly, communication with the public regarding heat warnings, health issues associated with extreme heat events, and tips on how to stay cool during the summer should be a priority for any municipality experiencing the effects of UHIs.

As the UHIE continues to become more severe due to climate change and anthropogenic activities, mitigating efforts should be made to reduce negative impacts. Urban parks offer city residents a variety of different benefits, but extreme heat events can discourage people from using parks during the summer months. Implementing proper park design will not only help improve thermal comfort, but help Windsor and other Canadian cities adapt to climate change and increase levels of physical activity in residents.

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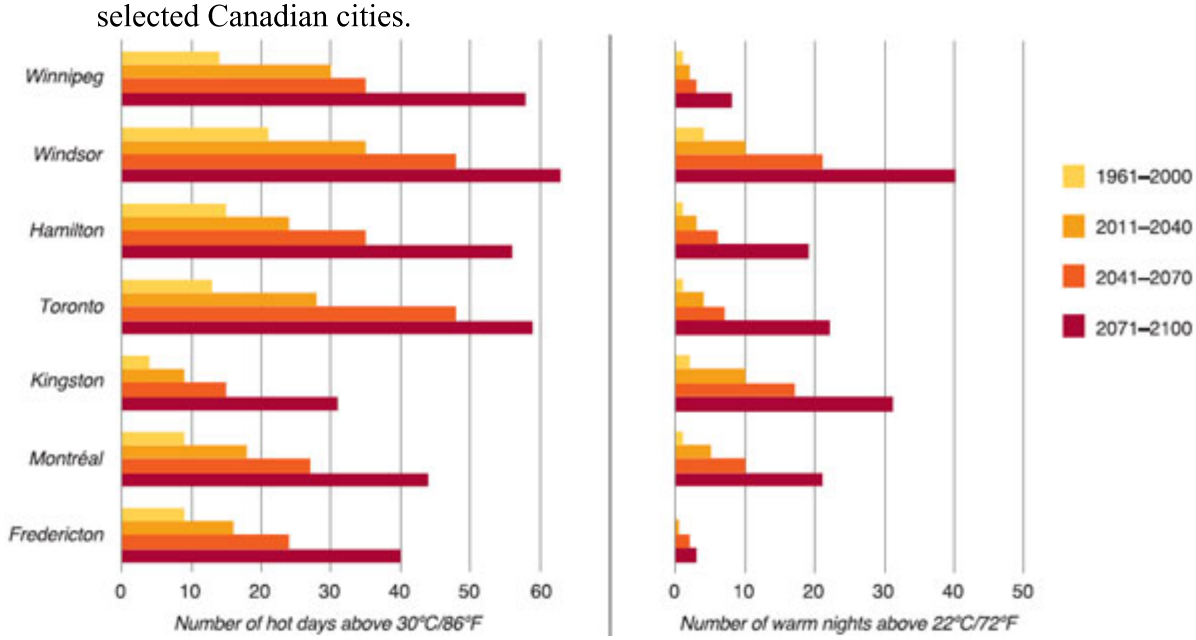
1.0 Introduction

The phenomenon known as the urban heat island effect (UHIE) occurs when there is a noticeable difference between temperatures recorded in rural areas and urban city centers (EPA, 2008). As urban development continues to rise, natural vegetation cover is being replaced with constructed materials and infrastructure. These materials, including asphalt and concrete, are highly impermeable and absorb heat much more than naturalized surfaces. It is because of this development that cities are known to be much warmer than their surrounding rural communities, especially during the summer months (EPA, 2008).

Anthropogenic activities and developments are also responsible for the growing concentration of greenhouse gases found in the atmosphere. Global warming has not only increased the occurrence and severity of climatic events (e.g. storms, drought, flooding etc.), it has also caused a drastic increase in temperature within city limits, making the UHIE much more prominent (Armson *et al.*, 2012). As temperatures continue to rise, the occurrence of extreme heat events experienced by Canadian cities are expected to increase (Figure 1) (Health Canada, 2011).

Figure 1: Historical and projected number of hot days and nights in selected Canadian cities.



Source: Health Canada, 2011

Urban parks are known to provide an escape from the summer heat due to the presence of vegetation and shade (Slater, 2010). Trees, shrubs, and grass cover lower air temperatures leading to more comfortable areas for local residents, especially during the summer months. This allows the public to engage in activities that can benefit their health and overall well-being. Despite this, parks are not immune to climate change and the urban heat island effect; increasing temperatures and poor design can lead to "hot zones" within parks and playgrounds. As climate change continues to influence UHI severity and impacts, urban park temperatures are rising, decreasing comfort levels, and causing an overall negative effect on surrounding communities (Armson *et al.*, 2012). Improvements in public health, reduction in environmental pollution, and the promotion of social development are benefits associated with the presence of urban green spaces (EPA, 2008). Because of these reasons, good design practices and policy implementation are critical in the improvement of thermal comfort in city parks.

A study completed in 2012, entitled '*The Urban Heat Island Effect in Windsor, ON: An Assessment of Vulnerability and Mitigation Strategies*', provided a detailed analysis of the causes and impacts of the UHIE. In order to reduce the impact of UHI's, the study recommended cool roof and pavement options, and provided a detailed explanation of how green space and vegetation can help reduce temperatures in urban areas (De Carolis, 2012). The full report can be found at http://www.citywindsor.ca/residents/environment/Environmental-Master-Plan/.

In 2013, the Corporation of the City of Windsor, along with Health Canada, initiated a second phase of the UHIE study to assess the impact on local urban parks. The goal of this study is to analyze current site conditions of Windsor's parks, and to produce recommendations that aim to improve park and playground design that accommodate increasing temperatures in urban areas. This information will support the City of Windsor's climate change adaptation goals. It will also encourage other Canadian cities to consider the implementation of heat resilient park design that will ultimately improve the thermal comfort of public spaces, and the overall health and well being of local residents.

This study was undertaken in five steps. First, information was collected by reviewing current literature and research studies that addressed topics involving the urban heat island effect, the impacts of parks and green spaces on urban temperatures, and mitigation techniques that can be employed to help improve thermal comfort in public spaces. Second, site data was collected at six of Windsor's public parks (Wigle, Meadowbrook, Captain John Wilson, Optimist Memorial, Ford Test Track, and Jackson Park) through observation, thermal audits, photographs, and surface temperature measurements. Third, public opinion regarding thermal comfort in local parks was collected through the distribution of a questionnaire. Fourth, current policy and documentation was reviewed in order to identify any supporting information with regards to the objectives of this study. Finally, recommendations were provided based on the findings of the literature review and data collected during site assessments.

2.0 Methodology

This section outlines the steps that were taken in order to complete this study. They include: reviewing current literature, identifying Windsor's parks and completing site level analysis, gathering additional data to support analysis, and producing recommendations.

2.1 LITERATURE REVIEW

Articles, research projects, and governmental documents with topics regarding the UHIE and thermal comfort in public spaces were included when completing a literature review. Documents that discussed climate change adaptation techniques, and specific design features known to reduce local temperatures in urban areas were also included. This information was used when compiling recommendations specific to improving the thermal environment in the City of Windsor's public parks.

2.2 IDENTIFICATION OF WINDSOR'S PARKS

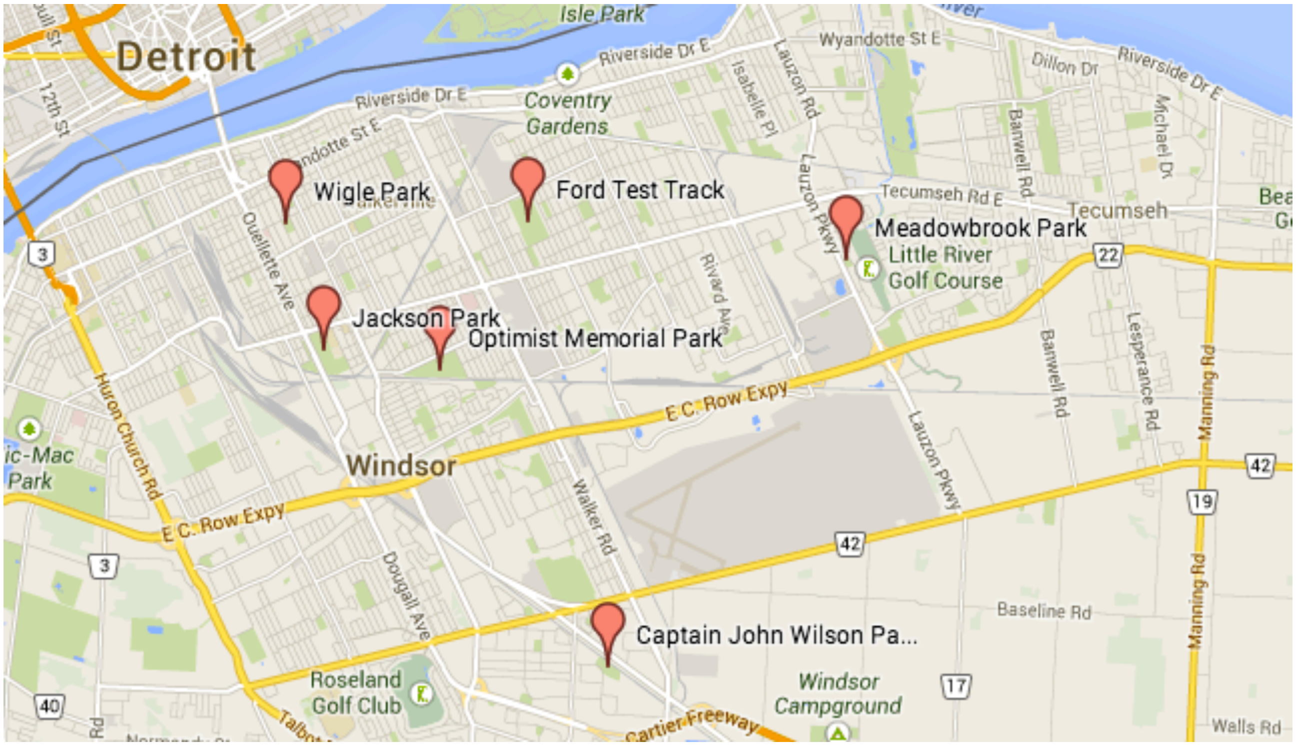
Windsor, ON has approximately 202 city parks and green spaces across the city. In order to assist with the site level analysis that was performed, each park was classified into one of three categories: neighbourhood, community, and regional. Specific characteristics were used to help place each park into a category; descriptions of each category are shown in Figure 2. There are a total of 136 neighbourhood parks, 34 community parks, and 32 regional parks throughout the City of Windsor.

Figure 2: Description of park classifications

Source: City of Vancouver, 2013; City of Windsor, 2013

In order to complete an accurate assessment of thermal comfort in Windsor's parks, a total of six parks were studied. Two parks from each classification were chosen; one being an example of a park that is more thermally comfortable than the other. By studying examples of both well and poorly planned park design, comparisons can be made, effective heat resilient strategies can be identified, and appropriate recommendations can be provided. The two neighbourhood parks chosen were Wigle and Meadowbrook Park, the two community parks chosen were Captain John Wilson and Optimist Memorial Park, and the two regional parks chosen were Jackson Park and Ford Test Track. The locations of the six parks are shown in Figure 3. Maps were created that display the six city parks and their respective city wards. These maps are included in Appendix A.

Figure 3: The location of the six city parks in Windsor, ON



2.3 SITE LEVEL ANALYSIS

Each park was visited during the study in order to complete a thorough site level analysis. Site visits allowed observations to be made that helped identify the current design features of each park. Each visit also helped to identify which features could be removed or included leading to a more comfortable thermal environment at each park. Since there are such a wide variety of elements that can affect the thermal comfort within a park's boundaries, site level analysis needed to incorporate all influential aspects. Factors that were taken into consideration during each park assessment were the state of the surrounding environment, the types of surfaces and vegetation present, and the types of activities occurring within the park. A thermal comfort and shade audit was completed at each of the six sites. Surface temperatures of various materials were also recorded throughout each park using an infrared thermometer (Appendix C-H).

2.3.1 Surrounding Environment

When arriving at each park, observations were made with regards to the surrounding environment. It is important to note whether the park is located in a suburban area, or in the middle of the city center, since surroundings can have an effect on wind currents, the amount of direct or reflected UVR etc. These factors can have an impact on the temperatures measured within the park. The infrastructure around each park, including the amount and type of surrounding greenery was noted and taken into consideration during each assessment.

2.3.2 Types of Surfaces

Surface type and area of coverage also has a major influence on heat comfort within a park; therefore, each type of surface present within the park was recorded, along with the estimated amount of coverage. Examples of common surface types seen in most of Windsor's parks include concrete, asphalt, gravel, sand, and vegetation. Materials used in built structures found on site, including rubber or plastic, were also analyzed since they can also contribute to temperature changes in a park environment.

2.3.3 Types of Activities

The types of activities and supporting facilities present on site were recorded. Examples of some of the activities and structures seen in Windsor parks include play structures, basketball courts, and soccer and baseball fields. These observations can help determine which types of people are using each park, for example, families, athletes, the elderly etc. As mentioned previously, certain populations are more susceptible to heat related health issues (De Carolis, 2012). To reduce risk, site-specific measures can be taken to increase thermal comfort based on who is attending and participating in city park activities.

2.3.4 Type of Vegetation

Since vegetation plays such an important role in regulating park temperature, the type, location, and amount of shade created, if any, were noted. The health, size, and location of trees were of particular interest; the amount of shade produced by this type of vegetation has a large part in creating comfortable resting areas in a park, as well as maintaining a cooler environment for park users. The placement of trees and the location of shade is an important factor that can dictate which kind of activities and which areas are most used by patrons. GIS systems were used to obtain an approximate measurement of vegetation and shade cover in each park. The aerial views that were used to calculate these values were taken in 2010; therefore, measurements have been subject to change over the past three years. By being aware of the amount of vegetation and shade cover in each park, it can be determined whether temperature values are influenced by these factors, and if so, what steps can be taken to increase the amount of vegetation and shade in Windsor's parks. Furthermore, the values obtained at sites classified as both good and poor park design examples will provide comparisons to determine the level of impact that vegetation has on park temperatures.

2.3.5 Thermal Comfort and Shade Audit

The amount of shade present in each park was analyzed using a shade audit. This audit looked specifically at the area where shade is found, which types of activities are performed in that area, and the amount of risk and level of priority associated with the area. The shade audit included an assessment of both natural and built shade structures. A thermal comfort audit was also completed for each park. This differed from the shade audit by including the reflectivity and emissivity values of park surfaces. It also looked at the placement and materials used to build play structures and water features, and took note of whether or not there were other facilities present such as community centers or stormwater retention systems.

2.3.6 Temperature Measurements of Park Surfaces

In order to obtain concrete evidence that shows not only the difference between temperatures of different materials, but also the difference between temperatures of shaded and unshaded areas, surface temperature measurements were made using an infrared thermometer. The *Commercial Electric* thermometer, model number MS6530H, is battery powered and can measure temperatures ranging from -30 to 300ºC. More information about the specific tool used can be found at http://www.homedepot.com/p/Commercial-Electric-Infrared-Thermometer-MS6530H/202353290. At each of the six city parks, multiple temperature measurements of varying surface materials were made. To make each measurement, the infrared thermometer was held approximately one meter away from the particular surface being studied. The types of surfaces that were measured were chosen based on the types of materials present in each park, and whether the surface was shaded or not. It should be noted that temperatures taken with the infrared device were largely affected by weather conditions, particularly by wind speeds.

2.4 ADDITIONAL DATA GATHERING TO SUPPORT ANALYSIS

Two additional data gathering activities were conducted in order to support the site level analysis that was done at each of the six city parks. A questionnaire was distributed to help consult the public and gather opinions from local Windsor residents with regards to the thermal environment in city parks. In addition, the rubber surfaces found in Windsor's playgrounds were studied; thermal images and temperatures measurements were recorded from various rubbers that are present in public parks. This information helps to distinguish which materials should and should not be included in park design when trying to improve thermal comfort.

2.4.1 Public Consultation

In order to obtain the opinions and concerns of Windsor's local residents, public consultation questions were distributed on two separate occasions. The goal of the questionnaire was to gather information from the public with regards to their park attendance, and how the high temperatures and humidity values can affect their park use. It also provided the public with the opportunity to express any ideas or recommendations they may have that could help increase thermal comfort in city parks.

By obtaining the opinions and recommendations from frequent park users, insight was gained on some of the benefits that parks provide the local population, as well as some of the park design issues that should be addressed. The information gathered will help inform Windsor's design and development team about the needs of local residents, leading to increased satisfaction with regards to the environment and comfort of city parks.

2.4.2 Playground Surfacing and Thermal Imagery

When installing new play structures, pre-existing sand pits are being replaced with a rubber surface. Rubber surfacing is thought to provide children more protection from fall related injuries (SofSurfaces, 2013). Although these benefits cannot be overlooked, the rubbers being used absorb and retain heat, and can have a negative impact on thermal comfort in parks. The City of Windsor has begun implementing different types of rubber surfacing into multiple municipal parks. In order to judge what kind of effect rubber surfaces have on park temperatures, three different types of rubber in three different city parks were studied: *Rainbow Turf Rubber Mulch* found at Little River Acres Park, *Pigmented Poured in Place Rubber* found at Captain John Wilson Park, and *SoftTile Premium Series* found at Meadowbrook Park. Details about these different rubber surfaces can be found in Appendix B.

Infrared images were taken of the rubber surfaces, and of the play structures, using a *Flir i7* infrared camera. This camera takes thermal images that show the amount of heat being radiated from an object. This camera also measures the surface temperature of any object within its focus. More information about this particular product can be found at http://www.flir.com/thermography/americas/us/. The thermal images and temperatures of each rubber surface was compared to identify which type would be best to use when considering the level of thermal comfort in a city park.

2.5 RECOMMENDATIONS

By compiling the information that was collected via the steps previously outlined, recommendations specific to the City of Windsor were produced. These recommendations aim to provide guidance and support when trying to improve the thermal environment in Windsor's city parks.

3.0 Literature Review

A literature review was completed in order to evaluate the current research regarding the effects and impacts of the UHI, the benefits of urban parks, the and design features that can be implemented to improve heat resiliency in public spaces. This review includes information that was gathered from recent articles, research papers, and government documents. The main findings include the benefits of having urban parks and cooler microclimates within a city, how to effectively plan for thermal comfort in public spaces, and urban park design options aimed at maintaining a comfortable thermal environment for park users.

3.1 URBAN HEAT ISLAND EFFECT AND PARK MICROCLIMATES

The urban heat island effect (UHIE) occurs when urban areas are significantly warmer than their surrounding rural areas. Impervious surfaces, such as concrete, asphalt and dark roofs absorb more heat, and cause an increase in ambient temperature up to 7ºC in urban centers (EPA, 2008). The UHIE is especially a concern during hot summer days, and is expected to become more prominent as climate change causes a global increase in temperature (Armson *et al.*, 2012). The risks associated with UHIs can differ based on social and demographic factors; children, the elderly, people living in poverty, and newly immigrated groups are known to have an increased sensitivity to heat that can lead to more severe health risks (Health Canada, 2011).

Urban parks are known to provide an escape from the summer heat due to the presence of vegetation and shade. It is through evapotranspiration that trees and other plants are able to cool down their surrounding environment. Evapotranspiration is the process that combines transpiration (the movement of water absorbed by the roots and emitted by the leaves) and evaporation (the conversion of water to gas). Together, these processes use heat from the sun to evaporate water which causes a cooling effect; a single tree can transpire up to 100 gallons of water a day (EPA, 2013; Akbari, 1992). Tree canopies also provide shade by blocking or reflecting up to 90% of sunlight. This limits the amount of solar load being absorbed by surrounding surfaces, reducing temperatures and preventing the formation of urban heat islands (EPA, 2008). Evapotranspiration coupled with shading can lead to the reduction of temperature up to 5 ºC (9 ºF). This can result in a cooler environment within the park area (Akbari, 1992; Potchter *et al.*, 2006). This phenomenon is known as the 'Park Cool Island' (PCI) or 'Oasis Effect', and occurs when an isolated moisture source, such as an urban park, is cooler than the surrounding region (Slater, 2010; Potchter *et al.,* 2006).

The cooling intensity of an urban park is highly dependent on certain park characteristics. The tree canopy coverage and types of pavements used are the two most influential factors affecting the cooling capabilities of each park. Other factors include the urban morphology surrounding the park, the spatial arrangement of vegetation, and the size of each park; large parks are generally much cooler than small parks (Chang *et al.*, 2007). The Park Cool Island is not limited to the park itself. The cooling effect felt in parks can extend up to 100 metres beyond the park's boundaries, helping to create a cooler neighbourhood for local residents (Slater, 2010).

Cool and Heat Islands can also be referred to as being microclimates: small, specific areas that have a different climate compared to the surrounding environment (Chen *et al.*, 1999). Characteristics that define a microclimate include air temperature, pressure, velocity, and humidity (Chen *et al.*, 1999). As vegetation and shade provided by urban parks lead to lower temperatures, this also contributes to cooler microclimates. These cooler conditions increase human thermal comfort in public areas, reducing heat stress that is caused by the UHIE (Potchter *et al.*, 2006).

3.1.1 Benefits of Cooler Microclimates for Thermal Comfort

Human Health

Thermal comfort can be defined as the "condition of mind which expresses satisfaction with the thermal environment" (ASHRAE, 2010). It is a subjective sensation, and can vary from person to person, and is difficult to quantify since it relies on both personal preference and physical environment. During the summer months, a comfortable temperature is said to be between 23-27ºC. When temperatures exceed 27ºC, which is a frequent occurrence in Windsor especially when considering humidity values, heat stress can have a significant impact on the productivity and health of an individual (Epstein & Moran, 2006). Figure 4 shows how both the temperature and relative humidity contribute towards heat index values, which influence human thermal comfort (UNDP/ENVSEC, 2011). Sensitivity to heat varies for each individual; therefore, considerations such as air temperature and humidity, as well as metabolic rate and socioeconomic status should be included when trying to measure thermal comfort (HSE, 2013). Urban heat islands are known to decrease thermal comfort, causing an unpleasant microclimate for local residents (Potchter *et al.*, 2006).

<u>Figure 4:</u> Heat index values corresponding to temperature and humidity levels.

Values of heat Index (human thermal comfort)

Temperature (C°)

Relative humidity	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	40°	41°
90%	28.0	30.7	33.8	37.1	40.7	44.7	48.9	53.5	58.5	63.7	63.7	75.1	81.2	87.7	94.5	101.6
85%	27.9	30.2	32.9	35.9	39.1	42.7	46.6	50.8	55.2	60.0	65.1	70.4	76.1	82.1	88.3	94.9
80%	27.7	29.7	32.1	34.7	37.7	40.9	44.4	48.1	52.2	56.5	61.2	66.1	71.3	76.8	82.5	88.6
75%	27.5	29.3	31.4	33.7	36.3	39.2	42.3	45.7	49.4	53.3	57.5	62.0	66.8	71.8	77.0	82.6
70%	27.3	28.9	30.7	32.7	35.0	37.6	40.4	43.5	46.8	50.3	54.2	58.2	62.5	67.1	71.9	77.0
65%	27.1	28.5	30.0	31.8	33.8	38.7	38.7	41.4	44.4	47.6	51.0	54.7	58.6	62.7	67.1	71.7
60%	26.9	28.1	29.5	31.0	32.8	34.9	37.1	39.5	42.2	45.1	48.1	51.4	55.0	58.7	62.6	66.8
55%	26.7	27.7	28.9	30.3	31.9	33.7	35.6	37.8	40.2	42.8	45.5	48.5	51.6	55.0	58.5	62.3
50%	26.6	27.4	28.5	29.7	31.1	32.6	34.4	36.3	38.4	40.7	43.1	45.8	48.6	51.6	54.8	58.1
45%	26.4	27.1	28.0	29.1	30.3	31.7	33.3	34.9	36.8	38.8	41.0	43.4	45.9	48.5	51.3	54.3
40%	26.3	26.9	27.7	28.6	29.7	30.9	32.3	33.8	35.4	37.2	39.1	41.2	43.4	45.8	48.3	20.9
35%	26.0	26.6	27.4	28.2	29.2	30.3	31.5	32.8	34.3	35.8	37.5	39.3	41.3	43.3	45.5	47.8
30%	25.8	26.4	27.1	27.9	28.8	29.7	30.8	32.0	33.3	34.7	36.2	37.8	39.4	41.2	43.1	45.1

Note: Exposure to full sunchine can increase heat index values by up to 10°C

Source: UNDP/ENVSEC Study on Climate Change Impact for the South Caucasus, 2011.

There are a variety of benefits associated with cool microclimates present in urban parks. Public health is the greatest concern when discussing the occurrence, exposure, and vulnerability to extreme heat events (TCPC, 2010). A cooler microclimate can lower exposure to extreme temperatures which can subsequently reduce the threat of heat stroke, exhaustion, cramps, and other heat related ailments, especially for high risk populations (Vanos *et al.*, 2010). Cooler park environments have higher attendance rates, especially in parks that have well shaded areas (Lin *et al.*, 2013). These cooler environments increase thermal comfort, which will ultimately lead to increased participation in physical activities that include walking, jogging, and organized sports such as soccer or baseball (Vanos *et al.,* 2010). Tree shade also offers protection from harmful ultraviolet radiation (UVR) emitted by the sun .UVR is a known carcinogen, and extended exposure can lead to skin cancer, and premature skin aging and wrinkling. Park shade provides UVR protection to park users, reducing the risk of skin cancer, especially to vulnerable individuals such as children (TCPC, 2010).

Biodiversity & Other Co-Benefits

In addition to human health improvements, there are a number of co-benefits that are provided by the presence of urban vegetation:

- Root systems of trees and shrubs help maintain soil quality and, consequentially, reduce soil erosion and stormwater runoff incidences (EPA, 2008)
- Through photosynthesis, urban vegetation can eliminate air pollutants, and reduce the amount of green house gases in the atmosphere. Improving air quality encourages residents to be outdoors, which can also contribute to increased physical fitness (EPA, 2008)
- Plants can improve quality of life by providing habitats for wildlife, reducing urban noise and crime rates, and can help decrease stress and aggressive behaviour in residents (Akbari, 1992)
- Since urban vegetation causes a decrease in local air temperatures, this can reduce reliance on air conditioning systems resulting in decreased energy demand (EPA, 2008)

3.2 PLANNING FOR THERMAL COMFORT

Although city parks are generally cooler than their surroundings, as the increase in global temperature and the UHIE become more prominent, proper planning and design measures need to be taken in order to ensure thermal comfort is maintained in these areas (Chang *et al.*, 2007). Before implementing specific park design and development ideas, certain factors should be taken into consideration. These include local climate characteristics and the amount of urban development in the area (Armson *et al.*, 2012). By incorporating these issues into park planning, proper design elements can be employed, thereby lowering temperatures in urban parks and increasing thermal comfort.

Urbanisation not only causes the UHIE, but can also disrupt the air flow within a city (Armson *et al.*, 2012). Dense built form and tall buildings trap short wave radiation, and reduce air movement within city limits (Chang *et al.*, 2007). As temperatures rise in city centers, warm air is advected into urban parks which negatively effects thermal comfort for local park users (Armson *et al.*, 2012). It is for this reason that design techniques should take into account the built up surroundings adjacent to an urban park; large buildings can disrupt wind velocity, and alter the amount of direct, or reflected, UVR that reaches surfaces (Chang *et al.*, 2007).

The type of climate observed in a city can vary based on geographical location. Daily average temperatures and humidity levels are two characteristics that are influential on the thermal comfort of an area. Climate can also be strongly affected by large bodies of water. Since no two cities demonstrate identical climatic conditions, it is important for planners to consider what specific climate characteristics will affect their design projects (Armson *et al.*, 2012). A challenge faced by design teams is trying to transform complex climate information or scientific concepts into planning ideas or actions. Using specific landscape features and urban development processes relative to local climate conditions, proper park design can help ensure cooler temperatures and increased thermal comfort in urban parks (Chang *et al.*, 2007).

3.3 URBAN PARK DESIGN

Once all factors that can influence a park environment (i.e.: local climate conditions, surrounding environment, human activity etc.) are taken into consideration, there are certain design measures that can be implemented to help ensure optimal thermal comfort in parks. Proper placement of shade structures and planting of trees, incorporating water features, and using appropriate building and walkway materials will help keep park temperatures low throughout the summer.

3.3.1 Natural Cooling Options

The presence of vegetation in an urban park helps to naturalize the area, and provides shade for cooling, resulting in a more enjoyable environment for park users. Trees are the most effective type of vegetation when it comes to cooling (Slater, 2010). When designing a park, specific guidelines should be followed when planting and maintaining trees. Specific tree species should be chosen based on size and rate of maturity, canopy coverage, and allergen potential (Giguère, 2009). In order for a tree to have a measureable cooling effect, it must reach an appropriate size. There is a direct relationship between the size, density, and quality of vegetation coverage and the local air temperature; the more canopy coverage there is, the cooler the park will be (Potchter, 2006). Trees generally take longer to reach maturity compared to other types of vegetation. A tree that is effective at providing shade should filter out at least 60% of UVR (Giguère, 2009). Faster growing alternatives include bushes or vines on trellises that could also provide shade, and require less maintenance (EPA, 2008). Deciduous trees should be favoured because their canopy will provide shade during the summer months, but they will lose their leaves in the fall allowing more sunlight to penetrate and warm the area during the winter (Akbari, 1992).

It is difficult for urban trees to reach maturity due to harsh environmental conditions, and poor planting techniques (Harris, 2004). Urban trees are susceptible to physical damage caused by lawnmowers, automobiles, and construction activity. Their rate of growth can also be affected by compacted soils, lack of watering, and pollution collected by run-off from the surrounding environment (Center for Watershed Protection and US Forest Service, 2008). When planting a tree, the space available needs to be able to accommodate the full size of the tree. Soil depth and quality has a major influence on tree health, and requires regular monitoring to ensure adequate nutrient and moisture supply (Giguère, 2009). If these precautionary measures are not applied, the likelihood of newly planted trees surviving more than two years is low (Harris, 2004). This will result in an unnecessary use of city funds, and will have a negative impact on the park environment.

Choosing the appropriate type of vegetation to include in park design is important. Certain plants are known to emit volatile organic carbons (VOCs) or have high allergy potential. VOCs are compounds found in the atmosphere that can contribute to the formation of smog. These compounds can include hydrocarbons, monoterpenes, and isoprene. In addition, plant species that have a high allergenic potential (Table 1) can have a negative impact on people who are susceptible to allergic reactions (Giguère, 2009). As a result, people may be less inclined to use public spaces, which may cause a decrease in physical activity and an overall decrease in public health. Using a native plant species will help ensure that the chance of survival is high since the plant has already adapted to the local environment, and will require less maintenance (Akbari, 1992).

Table 1: Trees with allergenic potential

Tree Species	Allergenic Potential
Birch, Oak	High
Alder, Ash	Moderate
Walnut, Poplar, Willow, Elm, Maple	Low

Source: Giguere, 2009

Tree placement within a park has equal importance to the type of species chosen. Proper tree placement ensures that the most important areas are shaded during the most critical times of the day (Akbari, 1992). Between 11:00am and 4:00pm is when the UV index is highest, and patrons are most susceptible to heat related illnesses and skin cancer. Park areas that require maximum shading include any area of high activity such as play structures, sports fields, walkways, and sitting areas. Shading in these areas is especially important if the main users are young children or the elderly since these populations are more at risk (TCPC, 2010).

When planting new trees in a park, using land that has already been displaced will reduce the environmental impact and landscaping costs (Harris, 2004). Depending on the location of the park, and the type of facilities present, trees should generally be placed along the south or southwest border. This will provide adequate shading from the summer sun (TCPC, 2010). If community centers or other buildings are located on site, large trees should be planted along the west side to prevent heating from the sun and save on energy costs (EPA, 2008). By incorporating natural shade options and proper planting techniques, outdoor public areas can be dramatically enhanced, which will ultimately lead to increased park participation.

3.3.2 Constructed Cooling Options

Example of a permanent shade structure in Optimist Memorial Park, Windsor ON.

The installation of shade structures is another option for increasing shade and thermal comfort in parks (Refer to Table 2 for comparisons between natural and constructed shade options). Similar to natural shade, a functional shade structure should provide maximum shade coverage over high activity areas during the critical time when the sun is at its peak intensity between 11:00am and 4:00pm (Apollo Sun Guard, 2013). Constructed shade structures not only provide cooling benefits, but can protect users from rain or harsh winds, can collect rainwater and contribute to a stormwater retention system, and can support solar panels or vegetation in order to reach optimal cooling potential. Shade structures made of appropriate materials, and placed in an area that minimizes vandalism and provides optimal shade coverage will be the most effective when trying to improve thermal comfort within a city park (TCPC, 2010). Constructed shade structures can be permanent, temporary, and/or portable (TCPC, 2010).

Table 2: Comparing Types of Shade

Type of Shade	Examples	Benefits	Drawbacks	Where to obtain
Natural	Trees, shrubs, vines	•Can be very effective depending on the density of the foliage •Can offer seasonal variations in scent and colour •Aesthetically pleasing •Improves the quality of the environment	•If newly planted, may take years to reach maturity and provide adequate shade •Requires maintenances especially for new trees •Some plants may be poisonous or attract bees/insects	Local nurseries and tree farms
Constructed *(portable, temporary)*	Umbrellas, awnings, tent-like structures	•Price: can be found at very reasonable prices •Ideal for some locations such as the beach •Can be adapted for use in a variety of situations •Readily available	•Provides a temporary shade solution •Usually suitable for only one or a few people •Requires maintenance	Local businesses such as hardware stores and home stores Shade manufacturers
Constructed *(permanent)*	Awnings, pavilions, gazebos, constructed structures	•Provides a permanent shade solution •Can provide shade to a large number of people	•Price: can be expensive •Requires more extensive planning to implement •Requires maintenance	Local businesses such as hardware stores and home stores Shade manufacturers

Source: TCPC, 2010

3.3.3 Water Features

Water features can have a large effect on the microclimate of a public park. Water fountains, waterfalls, and spray pads can improve thermal comfort by decreasing temperatures in the area up to 7.5%. Features that incorporate moving water, such as waterfalls, can improve air movement and circulation. The presence of water can also improve cooling through evaporation and the absorption of heat from other materials (Love, 2009). Play areas that have water features such as spray structures or splash pads offer a cool zone where patrons, especially young children, can cool off during hot days while increasing their physical activity. These features also provide a psychological cooling effect, meaning that while temperatures may remain the same, the presence of water causes the area to seem cooler and more comfortable for park users (Love, 2009).

Example of a splash pad installed at Center Island, Toronto ON.

Stormwater retention lakes and ponds are other examples of water features that can be included in park design. These features also provide co-benefits that include preventing water surges resulting from large storms, providing habitats for species that are water dependent, and storing water for irrigation purposes (Byler, 2008). Stormwater systems in urban parks can improve thermal comfort, and can create a more enjoyable environment for park users. Manmade lakes and ponds can help prevent flooding in sensitive areas, and can also help improve local water quality depending on the type of vegetation present. Since some species are heavily dependent on water quantity and quality, lakes and ponds can increase biodiversity. This can result in cleaner water, improved nutrient recycling, pollination of flowers, and an overall increase in ecosystem resiliency (Action Biodiversity, 2013).

3.3.4 Types of Materials and Surfaces

Emissivity: "The ability of a surface to emit energy that is accumulated."

Albedo: "The fraction of incident solar energy that is reflected from a surface."

As urbanization increases, the change from natural ground cover to manmade materials is becoming more prominent. Impermeable materials, such as asphalt, concrete, and roofing material are the most common materials present in cities, and are major contributors to the UHIE. Impermeable ground cover leads to the inability to absorb or filter water. This can lead to not only an obstruction of natural water flow, but can restrict the availability of clean water in cities. Decreased water absorption will result in unhealthy vegetation and disrupt the natural evaporative cooling process needed to offset urban warming (Giguère, 2009). In addition, manmade materials tend to absorb and store heat much more readily compared to natural cover. Concrete and asphalt have low albedo, meaning that the ability of these materials to reflect solar radiation is poor (Giguère, 2009). A list of materials and their respective albedo and emissivity values can be seen in Table 3. These values are measured on a scale of 0 to 1; albedo values close to 1 reflect more solar energy, while emissivity values close to 1 will emit more heat.

Table 3: Albedos and emissivity factors of various materials

Material	Emissivity Factor	Albedo
Polished Aluminum	0.1	0.9
Dirty Concrete	0.9	0.2
Dark Wood	0.95	0.15
Red Brick	0.9	0.3
Tarnished Copper	0.4	0.4
White Marble	0.9	0.6
White Paint	0.9	0.8
Plaster	0.9	0.9
Asphalt	0.9	0.1

Source: Giguère, 2009; Jacobson & Ten Hoeve, 2012

To help increase the cooling effect seen in urban parks, materials with high albedo and emissivity should be used. Materials with these properties will ensure that solar radiation is being reflected back into the atmosphere rather than being absorbed, avoiding the accumulation of energy in the material itself. Up to 60% of an urban area is covered with dark roofs and pavements (Global Cool Cities Alliance, 2012). Dark materials usually have low albedos; therefore, on hot days, these surfaces can reach temperatures up to 80ºC (Giguère, 2009). In order to avoid the accumulation of heat in urban parks, certain design ideas can be used. Walkways, bike paths, and parking lots can be paved with coloured asphalt or concrete; reflective pigments incorporated into the material can help increase albedo. Whitetopping is another technique that can be used. This involves pouring a 2.5-10 centimetre layer of white concrete on top of asphalt; the white material will have a higher albedo and emissivity then the dark asphalt (Giguère, 2009). Although whitetopping results in reduced heat absorption, lighter concrete requires more maintenance since over time the colour will darken with use, rendering it ineffective at reducing the UHIE. The ability for a surface to absorb and store heat is dependent on the thickness of the material; therefore, thinly laid asphalt or concrete will be cooler than thicker layers (Golden and Kaloush, 2006). Parks that consist of paved surfaces covering 50% or more of the total park area will be warmer than their surroundings (Chang *et al.*, 2007). Although thermally comfortable options are available for walkways and bike paths, vegetation coverage is much more effective at reducing heat in urban parks.

Similarly, the building materials used to construct play structures can affect park temperatures. One option to reduce the heat retained by building materials is to apply high reflective paint over the initial structure (Giguère, 2009). Incorporating natural or constructed shade features into play structure design will also help maintain a comfortable park environment. Play areas are mainly used by youth, making them high priority locations for shade implementation since young children are more susceptible to heat related illnesses (TCPC, 2010). Shading play structures will not only improve thermal comfort within the park boundaries, but will also decrease the rate of heat related illnesses. Shade will also reduce heat absorption by play equipment that can lead to thermal burns, and in turn encourage patrons, especially children, to be more active (Apollo Sun Guard, 2013).

3.4 DESIGN SUPPORT TOOLS

When designing a thermally comfortable park, using a holistic approach is the most effective way to consider all the factors that influence a thermal environment. This includes taking note of the surrounding environment, the needs of local community members, and local climate conditions. Being aware of these factors will allow designers to implement an appropriate strategy that will ensure a cool park climate for patrons. Support tools that can be used by design teams include:

- Site assessment
- Thermal imaging
- Life cycle assessment
- Online resources

3.4.1 Site Assessment

A site assessment is an evaluative tool that helps a design team outline the steps that need to be completed in order to develop thermal comfort solutions for urban parks. This type of assessment includes completing a site inventory which looks at current landscaping and design features, as well as completing a shade audit. A shade audit evaluates the amount of shade provided in a park, and helps to produce recommendations that consider the type of activities, the type of park user, and the time of day the park is being used (TCPC, 2010). A shade audit helps designers decide what type of shade, whether natural or constructed, will be most effective to improve thermal comfort in an urban park (Waterloo Region Shade Work Group, 2011). Site assessments and shade audits are necessary when beginning to implement a heat sensitive park design. Each design plan will differ depending on the specific park. Using assessment and audit tools will ensure the best suited plan will be used for each park.

3.4.2 Thermal Imaging

Thermal images and surface readings of parkland help to study the urban climate and the local urban heat island effect. These tools can identify the effect that urban development has on local temperatures, and what areas within a city are the most at risk (Voogt & Oke, 2003). Using satellite imaging, thermal maps of an urban area can be produced. These images highlight which areas are warmest, and when compared to socio-economic data, can determine which areas will be affected most by high temperatures and humidity (refer to the ‘UHIE in Windsor, ON’ report for thermal maps and socio-economic data specific to the area). Infrared pictures are also a useful tool to use when comparing the temperatures of different materials or surfaces. Different materials retain heat differently; therefore, the use of an infrared camera can produce images identifying materials that may not be suitable to include in a thermally conscious park design.

Thermal imaging is an effective way at not only determining which areas require major heat mitigation efforts, but also determines which materials should and should not be used to reduce temperatures in urban parks (Samuel *et al.*, 2010). These images are also useful when trying to understand the thermal performance of materials in urban parks, and can help municipalities improve their climate change adaptive capacity (Samuel *et al.*, 2010).

3.4.3 Lifecycle Assessment

When mitigating the UHIE through heat sensitive park design, many techniques are available. Budget constraints, local, provincial and national regulations, and site specific conditions can impact what measures are implemented to improve thermal comfort and reduce the UHIE. Therefore, it is important to understand what options are available, the benefits and drawbacks of each measure, and the overall impact a UHI mitigation strategy will have on the environment.

A lifecycle assessment (LCA) is a technique used to measure all impacts associated with each stage of a product's lifespan. A lifecycle assessment completed for specific heat mitigation measures will allow a design team to make informed decisions about what strategy should be used when implementing a thermally sensitive park design (Martineau and Samson, 2011). A LCA completed by the *Interuniversity Research Centre for the Life Cycle of Products, Processes and Services* looked at ten urban heat island strategies. The operation, maintenance, and dismantling impacts were studied for each mitigation measure. A list of these strategies and their impacts on the local environment can be seen in Figure 5.

Figure 5: Functional profile of the assessed UHI mitigation measures, compared to the baseline scenario*

	"The implementation, in 2010, and the continued application over a 30-year period of an individual urban heat island mitigation measure on a residential block of a large urban centre in the province of Quebec"	UHI mitigation measures									
		1	2	3	4	5	6	7	8	9	10
Functional profile	Reduction of the ambient temperature	+	+	+	+	+	+	+	+	+	+
	Reduction in drainage and flooding problems associated with sewer overloading	++		+	+	+		+	++	++	++
	Aquifer recharge			+	+	+		+	++	++	++
	Creation of wildlife habitat	+		+	+	+			+		
	Improved air quality	+		+	+	+			+		
	Improved water quality	+							+		
	Reduction in ambient noise	+		+	+	+			+		
	Beautification of urban neighbourhoods			+	+	+			+		

Légende

1	Green roof
2	Reflective roof
3	Green wall
4	Planting arrangement (border)
5	Tree
6	Reflective pavement / surface
7	Permeable pavement / surface
8	Rain garden
9	Infiltration trench
10	Dry well

++	Strong link between a function and a component
+	Link between a function and a component
	No significant link

*Baseline scenario: a situation where no UHI mitigation measures have been taken
Source: Martineau and Samson, 2011

3.4.4 Online Resources

Since the UHIE and its impacts on the thermal environment in public spaces has become a concern for many municipalities, there are a number of comprehensive documents and online resources available for cities looking to improve thermal comfort in these areas. These resources provide extensive information about impacts associated with UHIs, the benefits of cool microclimates in cities, and strategies on how to plan and preserve thermal comfort levels in urban areas. These online resources (Table 4) are easily accessible, and can prove to be useful for municipalities interested in improving thermal comfort in public spaces, such as urban parks.

Table 4: Descriptions of online resources that provide information on improving thermal comfort in public spaces.

Resource	Description
Evergreen	Evergreen is a national not-for-profit that aims to restore natural environments within communities. They are an advocate for school ground greening, and provide information regarding design ideas for school areas that include shade and energy conservation strategies. More information is available at http://www.evergreen.ca/en/resources/schools/planning-design.sn (Evergreen, 2013).
City of Toronto Shade Guidelines 2010	The Shade Guidelines were written by the Toronto Cancer Prevention Coalition with hopes of increasing the amount of shade throughout the city in order to reduce UVR exposure. The document provides useful information and steps on how to perform a shade audit, and the benefits of implementing natural and constructed shade devices in public spaces. More information is available at http://www.toronto.ca/health/tcpc/pdf/shade_guidelines.pdf (TCPC, 2010).
Region of Waterloo Shade Audit Information Guide and Tool	The Waterloo Region Shade Work Group produced this Shade Audit document that describes the co-benefits associated with both natural and built shade structures, how to successfully complete a shade audit, and design ideas that should be considered for public spaces. More information is available at http://chd.region.waterloo.on.ca/en/healthyLivingHealthProtection/resources/ShadeAudit_GuideTool.pdf (Waterloo Region Shade Work Group, 2011).
Nature Québec	Nature Québec provides useful tools and information for municipalities looking to preserve 'Park Cool Islands', as well as mitigation techniques that can help battle the impacts of the UHIE. More information is available at http://www.naturequebec.org/projets/nature-et-fraicheur-pour-des-villes-en-sante/outils/ (Nature Québec, 2013)

Preserving cool microclimates in urban areas, such as the ones found in city parks, is crucial for the health of a community (Slater, 2010). Improving the thermal comfort in Windsor's parks during the summer months will provide residents a cool environment that they can use during extreme heat days. Adapting current park design by increasing vegetation coverage and implementing built shade structures, water features, and cool materials will have an effect on park temperatures. Using specific resources such as site assessments, thermal imaging, and lifecycle assessments will help municipalities make more informed decisions when implementing new thermally conscious park designs. Installing heat resilient park design features, combined with the information provided by online resources will undoubtedly lead to improved thermal comfort in Windsor’s city parks.

4.0 Public Policy Context

Public policies surrounding Windsor's environmental initiatives help establish procedures and protocols that are needed to ensure the success of these programs. The City of Windsor has developed and implemented a number of policies, and has produced supporting documentation, that apply to the environmental goals and general development plans the City has in store for the future. In this section, various policies and documents involved in UHI considerations are reviewed, and limiting factors affecting proper integration are identified. Some of the information that applies directly to reducing the UHIE and improving park environments include The City of Windsor's Official Plan, the Environmental Master Plan, the Climate Change Adaptation Plan, the Urban Heat Island Study, and information provided by the Windsor Essex County Health Unit.

4.1 PLANS AND POLICIES

Windsor's Official Plan

The City of Windsor's Official Plan is a document that provides guidance for the physical development of the city over a 20 year span. This document includes social, economic, and environmental factors that are considered when implementing a policy framework. Environmentally, the Official Plan provides details about goals the City wishes to accomplish with regards to sustainable living, environmental awareness, and urban development. Specific policies that have been implemented, and have an indirect effect on reducing the UHIE, include: increasing the quality and quantity of naturalized areas throughout the city, encouraging the protection of trees on both private and public land, and encouraging diversity and the planting of native trees. More information about Windsor's Official Plan is available at http://www.citywindsor.ca/residents/planning/Plans-and-Community-Information/Windsor---Official-Plan/Pages/Windsor-Official-Plan.aspx.

Environmental Master Plan

This document was written and publically distributed in 2006. It provides details about the environmental programs and initiatives across the City, as well as recommendations on how Windsor can improve its environmental performance. The goal of this report was to influence stakeholders and gain support when taking action towards improving Windsor's environment. More information about Windsor's Environmental Master Plan is available at http://www.citywindsor.ca/residents/environment/environmental-master-plan/Pages/State-of-the-Environment.aspx.

Climate Change Adaptation Plan

Windsor's Climate Change Adaptation Plan is a relatively new document that was released in the fall of 2012. This comprehensive report provides details regarding climate change and the associated impacts in the Windsor region, as well as specific adaptive measures that can be taken to help prevent damage due to extreme weather events. The impacts specific to the Windsor region were ranked based on severity. Risk assessments were completed for each of these impacts, and based on the results, adaptation actions were recommended. Extreme heat events caused by climate change were identified as not only a public health risk, but also cause an increase in expenses dedicated to infrastructure repair. Adapting to extreme temperatures and humidity levels will help improve the resiliency of Windsor's community. More information on Windsor's Climate Change Adaptation Plan is available at http://www.citywindsor.ca/residents/environment/environmental-master-plan/Pages/State-of-the-Environment.aspx.

Urban Heat Island Study

In 2012 the City of Windsor and Health Canada collaborated to produce a study that looked at Windsor's vulnerability to urban heat islands and how negative impacts of extreme heat events can be mitigated. The report was entitled '*The Urban Heat Island Effect in Windsor, ON: An Assessment of Vulnerability and Mitigation Strategies*'. Using heat vulnerability mapping, the warmest areas in Windsor were identified. By comparing these results to socio-economic data, UHI mitigation measures and recommendations were provided that were specific to the Windsor area. The study found that populations including youth and the elderly, low income families, people who were uneducated, and newly immigrated groups are more vulnerable to illnesses and stress related to high heat and temperatures. The research done for this project supports the need to adapt environmental conditions in order to improve the thermal comfort of public spaces in Windsor. More information about Windsor's Urban Heat Island Study is available at http://www.citywindsor.ca/residents/environment/environmental-master-plan/Pages/State-of-the-Environment.aspx.

Heat Alert and Response Plan

The Heat Alert and Response Plan (HARP) was implemented in 2009 by the Windsor-Essex Health Unit. HARP coupled with *Stay Cool Windsor-Essex* campaign aims to promote prevention and protection techniques that are useful for Windsor residents during extreme heat warnings. These initiatives use weather information collected from Environment Canada to notify the local population when temperature and humidity levels are high enough to be detrimental to human health. By doing so, the public can have adequate time to take appropriate measures to stay cool during these extreme heat events. The public health unit for Windsor-Essex county works towards educating the public on the symptoms, treatment, and prevention of heat related illness. The health unit promotes proper sun safety techniques, and provides tips on how to stay hydrated and healthy during the hot summer months. More information about the Windsor Essex County Health Unit is available at http://www.wechealthunit.org/.

4.2 POLICY IMPLEMENTATION REGARDING THERMAL COMFORT

A review of both the plans and policies in section 3.1 shows that the City of Windsor is making a significant effort towards increasing the awareness of climate change effects on the area, and how specific environmental initiatives and steps can be taken to help mitigate these issues. As a result, many of these documents indirectly support the idea of improving the thermal comfort in Windsor's public spaces. Supporting climate change adaptation efforts, protecting trees and naturalized areas, and educating the public about risks associated with extreme heat events is crucial. These initiatives will undoubtedly have a positive effect on establishing a thermally comfortable environment for park users throughout the City of Windsor.

Despite the environmental efforts being made by the City of Windsor, there has been no implementation of policy directed specifically towards improving thermal comfort in public spaces. Policy regarding urban development and the concern for decreased thermal comfort can compliment the previously mentioned initiatives that the City of Windsor has already implemented. One option would be to include a thermal comfort policy into Windsor's Official Plan. This Plan is reviewed every five years, and provides an opportunity for new policies and objectives to be considered. Having a policy aimed towards improving thermal comfort will help the City establish new design options that will lead to cooler temperatures in public spaces, and will ultimately benefit the entire Windsor population.

5.0 Results of Site Level Analysis

This section provides details of the results found from the site level analysis completed at each of the six City of Windsor parks that were studied. The information gathered through observation at each site include the size and location of each park, the amenities found within park boundaries, the amount of vegetation and shade coverage provided, and the types of materials and surfaces present. The results are separated based on the classification of each park studied.

5.1 NEIGHBOURHOOD PARKS

Wigle Park

Wigle Park, Windsor ON

Wigle Park is a neighbourhood park, located in ward three in central Windsor. The surrounding environment is mostly residential, with smaller houses to the east, and a larger apartment complex to the west. Since the park is centrally located, there is very little green space or vegetation found in the surrounding area. The estimated perimeter and area of the park is 612.92m and 21598.96m^2, respectively. The north area of the park consists of large, healthy adult trees which provide heavy amounts of shading. This area of the park consists of grass cover and is where multiple benches and sitting areas can be found. A permanent built shade structure is placed north of the park as well. Underneath are concrete picnic benches. The structure itself is constructed from wood (frame), and metal (roof). The total shade coverage is estimated to be 5231.53m^2. The park has a baseball field and a small asphalt basketball court to the north, while the south section is a large soccer field. Two small swing sets are located at the north-east and north-west corners of the park, both placed in sand pits.

Despite the heavy shade provided by both the mature trees and shade structure in the north section of the park, the south section has little to no shade due to the large soccer field present. It is difficult to provide adequate shade over sports areas. Unshaded benches are placed around the perimeter of the soccer field for players to rest when they are not on the field. Benches and bleachers surround the baseball field, and the trees in the area provide a medium amount of shade. Due to the size of the park, a short walkway is present in the north section, which is made from asphalt, and largely shaded by trees. No water features are present.

The main activities in Wigle Park are baseball, basketball, and soccer with a small area provided that can host leisure activities. Depending on the time of day, and type of activity, the age of park users can vary. This can influence the amount of risk associated with sun and heat exposure, as well as the priority given to thermal comfort solutions. A total of ten temperature measurements were taken throughout the park. A map of the park with the locations of each measurement and their respective values are provided in Appendix C.

Meadowbrook Park

Meadowbrook Park, Windsor ON

Meadowbrook Park is a neighbourhood park, located in ward eight in east Windsor. The surrounding environment to the east is mainly residential, and the park is relatively close to a large green space, Little River Golf Club. The west side of the park is open to Lauzon Parkway, a major road in the city. The estimated perimeter and area of the park is 527m and 16174.28m^2, respectively. The park has recently undergone construction, replacing the older tennis court and play structure with newer developments. Since the construction took place during the summer of 2013, recent GIS images are not available. A new play structure and court have been implemented in the north area of the park accompanied with a gravel parking lot. The south area of the park consists of a large field with a short asphalt walkway along the perimeter. Young trees have been planted along the walkway, but some are not healthy, and all are not yet large enough to provide any shade; therefore, there is zero shade coverage within the park. There are a few benches and sitting areas in the park along the walkway. There are currently no built shade structures or water features present.

Many leisure activities take place in Meadowbrook Park including walking, jogging, and playing on the play structure. Because of the local residential population and the type of activities taking place within the park, it can be assumed that young children and their guardians are the main users. Consequentially, there is high risk of direct sun exposure associated with park use, and this park should have priority when discussing new thermally appropriate park design. A total of nine temperature measurements were taken throughout the park. A map of the park with the locations of each measurement and their respective values are provided in Appendix D.

5.2 COMMUNITY PARKS

Optimist Memorial Park

Optimist Memorial Park is a community park, located in ward four in central Windsor. The surrounding environment is mainly residential. A commercial sector of the city can be found north-west of the park, along with a major road, Howard Avenue. The estimated perimeter and area of the park is 2191.41m and 204605.33m^2, respectively. The park can be split up into two areas that are separated by a gravel parking lot. The majority of the east side of the park has vegetation cover including large, mature trees, a large naturalized area, and a fenced in dog park. The large trees provide heavy amounts of shade. The east side also has a large gravel pit play structure, as well as multiple picnic tables and sitting areas, some of which are placed underneath permanent built shade structures. Shade structures are constructed from wood (frame), and metal (roof). The west side of the park is oriented towards organized activities; there are three baseball fields, a basketball court, a large open field, and a community center. The baseball benches are shaded by permanent roofs; however, the bleachers for spectators are not shaded. The total shade coverage throughout the entire park is approximately 118211.08m^2; therefore, around 58% of the total park area is shaded by trees and built shade structures.

The majority of the park has vegetation coverage which includes both grass and large trees. An asphalt walkway winds through the entire park, allowing patrons to walk, jog, and bike. The basketball court is also covered in asphalt and offers little shade to patrons. The baseball diamonds and the two parking lots consist mostly of sand and gravel. There are no water features present.



Optimist Memorial Park, Windsor ON

Since there are such a wide variety of activities available to park users, all age groups can be found using the parks facilities throughout the day. Certain areas have higher direct sun exposure compared to others; the organized sports areas on the west side of the park provide little shade to patrons compared to the leisure area on the east side. A total of 16 temperature measurements were taken throughout the park. A map of the park with the locations of each measurement and their respective values are provided in Appendix E.

Captain John Wilson Park

Captain John Wilson Park, Windsor ON

Captain John Wilson Park is a community park, located in ward nine in south Windsor. The surrounding environment is composed of a new residential community. A large school can be found south of the park. To the north is a commercial area with high traffic streets. The estimated perimeter and area of the park is 1797.43m and 84099.29m^2, respectively. The park is covered mostly by grass, and small, immature trees that produce little shade. Similar to Optimist Memorial Park, Captain Wilson Park can be separated into two sections. The section to the east consists of a large open field, with little shade and few sitting areas. This area has recently undergone major reconstruction; therefore, aerial images of the new structures are not available. The old play structure has been removed and replaced by a new play structure, a splash pad, and a changing and washroom facility. On the west side of the park is a large stormwater retention lake that is surrounded by naturalized vegetation. Little shade and seating is provided. The entire park has an asphalt walkway around the perimeter providing patrons the opportunity to walk, jog, rollerblade etc.

Captain Wilson accommodates all age groups. With the installation of the splash pad and new play structure, young children and their guardians will no doubt be attracted to these facilities. In addition, the new community has a growing population which will lead to increased park use. Consequentially, the risk associated with this park is high, and priority should be given when considering thermal comfort redesign. A total of ten temperature measurements were taken throughout the park. A map of the park with the locations of each measurement and their respective values are provided in Appendix F.

5.3 REGIONAL PARKS

Jackson Park

Jackson Park is a regional park located in ward three in central Windsor. Due to its location close to the city center, there is very little green space surrounding the park. A combination of both residential and commercial areas can be found in the surrounding environment. The estimated perimeter and area of Jackson Park is 2564.67m and 255,284.83m^2, respectively. Ouellette Avenue, a main street in Windsor running north-south, splits the park into two separate areas. Being a main city attraction, the park has a number of amenities:

- Cricket Pitch
- Baseball Diamonds
- Baseball Stadium
- Windsor Football/Soccer Stadium
- Picnic Area
- Queen Elizabeth Sunken Gardens
- Privately Owned Parkside Tennis Club
- Copernicus Sundial
- South African War Memorial
- Land, Sea, Air Memorial
- Robert Burns Memorial

The majority of the park is covered in vegetation, mainly grass and large trees. Most of the trees are mature and provide adequate shade. There are a number of sitting and rest areas throughout the park, with bathroom facilities available on site. A comprehensive network of asphalt walkways has been established throughout the park, giving patrons the opportunity to increase their physical activity.



Jackson Park, Windsor ON

Since there are such a wide variety of amenities found in Jackson Park, the site attracts users of all ages. Leisure activities, soccer, baseball, and cricket are some examples of the main park activities. There is a water fountain found in the gardens on the north-east side of the park, and only one play structure located on the west side. The risk of increased sun exposure associated with Jackson Park is relatively low compared to the other parks that were studied, and depends on which area of the park is being looked at. For example, the play area which attracts young children is different than a shaded sitting area near the gardens. A total of 18 temperature measurements were taken throughout the park. A map of the park with the locations of each measurement and their respective values are provided in Appendix G.


Ford Test Track, Windsor ON

Ford Test Track

Ford Test Track is a regional park, located in ward five in central-east Windsor. The surrounding environment is residential. Other municipal parks can be found in the area; therefore, there is more green space present compared to the other parks that were studied. This park was the original test track for Ford Motor Company. Now it consists of two baseball diamonds, 15 soccer fields, and a circular track that is approximately 1.6 kilometres long. The estimated perimeter and area of the park is 2126.41m and 247,947.53m^2, respectively. There are two gravel parking lots located on site at both the north and south ends of the park. The park is covered by vegetation, mainly grass. A small sand pit play structure is located in the south-west corner of the park. Changing and washroom facilities are located on site. There are both spectator and players benches, all of which are not shaded. Some trees and naturalized areas have been planted along the perimeter of the park, but provide little shade. Along with the paved track, there are asphalt and concrete walkways throughout the park, providing patrons access to the sports fields. There are no water features present on site.

Since this park is dedicated to sports, particularly soccer, park use is mainly during the evenings from Monday to Friday, and during the day on the weekends. Soccer leagues have teams for all age groups, meaning that the park is frequently used during the summer months. Since park users are participating in a high level of physical activity, the risk level is high, making thermal comfort applications a high priority for the Ford Test Track. A total of twelve temperature measurements were taken throughout the park. A map of the park with the locations of each measurement and their respective values are provided in Appendix H. A summary of the results found in all six city parks can be found in Table 5.

Table 5: Summary of site level anaylsis

Park	Classification	Location (city ward)	Size (m^2)	Features/Activities
Wigle	Neighbourhood	Three	21598.96	Shaded picnic benches, soccer field, baseball field, basketball court, swing set
Meadowbrook	Neighbourhood	Eight	16174.28	Play structure, walking path, large playing field
Optimist Memorial	Community	Four	204605.33	Dog park, soccer field, baseball field, basketball court, play structure, shaded picnic and rest areas
Captain John Wilson	Community	Nine	84099.29	Walking path, play structure, splash pad, open play field, naturalized area
Jackson Park	Regional	Three	255284.83	Baseball field, shaded picnic and rest areas, memorials, gardens, walking path, play structure
Ford Test Track	Regional	Five	247947.53	Soccer fields, play structure

5.4 RESULTS OF PUBLIC CONSULTATION

A total of 53 people were surveyed during the public consultation process. The main findings of the questionnaire are summarized in Table 6.

Table 6: Main findings collected during public consultation

<table>
<tr><td colspan="2">Total number of Participants</td><td>53</td></tr>
<tr><td colspan="2">Average Age</td><td>35</td></tr>
<tr><td rowspan="3">Average Park Use</td><td>Time of Year</td><td>Summer</td></tr>
<tr><td>Time of Day</td><td>10:00am-6:00pm</td></tr>
<tr><td>Amount of Time Spent/Visit</td><td>1 to 3 hours</td></tr>
<tr><td colspan="2">Preferred Outdoor Temperature</td><td>22 to 28°C</td></tr>
<tr><td colspan="2">Main Activities</td><td>Walking, jogging, soccer, biking, play structure</td></tr>
<tr><td colspan="2">Main Recommendations</td><td>• Install splash pad/sprinkler system
• More drinking fountains/refreshment stands
• More trees/shade structures
• More recycling bins/trash cans</td></tr>
<tr><td colspan="2">Aware of “Stay Cool Windsor Essex” campaign</td><td>21%-yes 79%-no</td></tr>
</table>

Since completing the questionnaire was voluntary, there were certain discrepancies that arose. Some participants did not provide their age, while others chose not to answer certain questions. The way each participant perceived the content of the questionnaire was entirely subjective; therefore, the resulting information gathered was subject to certain inconsistencies and was deciphered to the best of the author’s abilities.

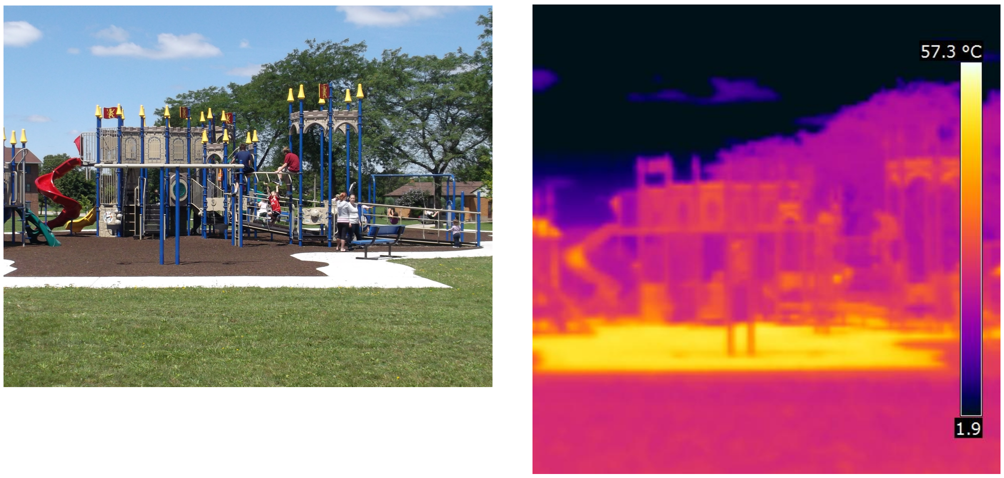
5.5 PLAYGROUND SURFACING CONCLUSIONS

Photographs and temperature measurements obtained using an infrared camera showed, that on a sunny day[1], the surface temperature of the rubber surfaces in Meadowbrook Park, Captain John Wilson Park, and Little River Acres Park were 60.5°C, 69.0ºC, and 51.6ºC, respectively (Figure 6). The *Pouring in Place Rubber* used at Captain Wilson proved to be the hottest surface, compared to *SofTile* rubber in Meadowbrook Park, and *Rainbow Turf* in Little River Acres Park which is the coolest option.

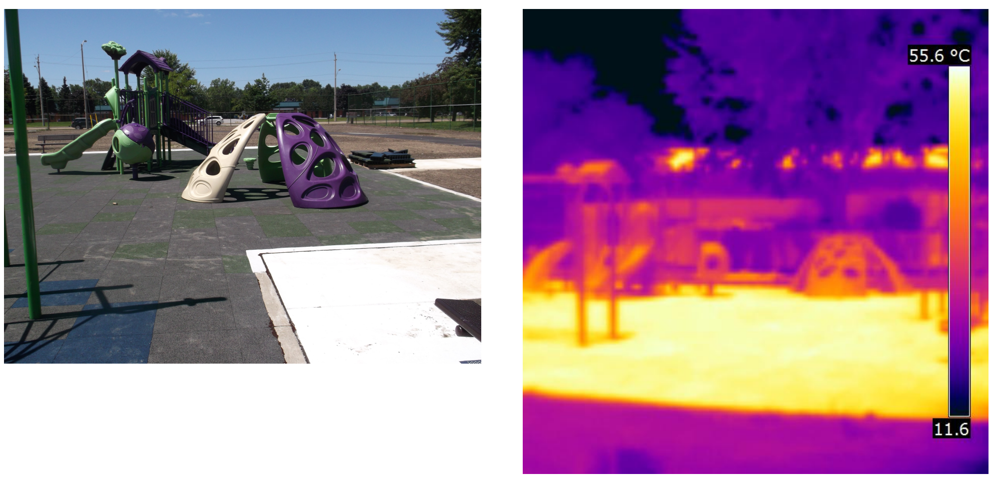
[1] The weather conditions on July 24th, 2013, when the temperature measurements for rubber surfaces were

<u>Figure 6:</u> Regular and thermal images of the play structures and rubber surfaces found at (1) Little River Acres Park, (2) Meadowbrook Park, and (3) Captain John Wilson Park

(1)



(2)



(3)

6.0 Discussion

Through research, data collection, and observation, city parks that were used as examples of proper park design (Wigle, Optimist Memorial, Jackson) generally provided a more comfortable environment for park users compared to their counterparts. These parks were observed to be used more frequently by Windsor residents. Not only did these parks offer more in terms of activities, but they also had a higher percentage of vegetation coverage and less paved surfaces, more shaded areas, and more sitting and rest areas.

The data collected during the site level analysis of each park showed results similar to those described in current literature. Temperature measurements of varying surfaces within a park showed that unshaded asphalt, a low albedo and high emissivity surface, can reach temperatures above 50.0°C during sunny, hot summer days (Appendix H). Compared to unshaded grass surfaces that can reach temperatures around 30.0°C, asphalt is significantly warmer. As a result, parks with large areas covered in asphalt will have a warmer park environment, leading to lowered thermal comfort and park attendance (Chang *et al*., 2007). Similarly, temperature measurements of shaded areas showed a significant difference compared to unshaded areas. An asphalt paved walkway was found to reach temperatures as low as 19.0°C when shaded by natural or constructed shade structures (Appendix E). Similar results were also found for shaded grass areas. The presence of shade, whether natural or built, will undoubtedly reduce surface temperatures in parks, as well as improve thermal comfort for park users (TCPC, 2010). Increasing shade coverage and the amount of vegetation in urban parks will also provide co-benefits that were previously mentioned in the literature review. These include maintaining soil quality, improving the local air quality through photosynthesis, and improving the quality of life for local residents by reducing urban noise and crime rates (EPA, 2008; Akbari, 1992).

The results of the public questionnaire provided valuable information about park use. Most participants indicated that the ideal outdoor temperature that they find most comfortable is 22 to 28°C. Despite this finding, 81% of participants who completed the survey indicated that their park use increased during the summer months, in spite of high temperatures and humidity values. The reasons for increased park use included participation in organized sports teams, and nicer weather conditions that make residents more willing to enjoy the outdoors. The main park activities that were indicated were walking, jogging, biking, and soccer. These activities are all highly physical, and require the participant to exert themselves to some extent. Increased park activity during summer month means that park users are exposed to extreme temperatures and harmful UVR, which can ultimately lead to increased rate of heat related illness (Health Canada, 2011). It is for these reasons that adapting park design to improve thermal comfort in public spaces should be a priority for the City of Windsor.

7.0 Recommendations

Example of a portable shade umbrella

Based on the information gathered through each park assessment, public consultations, and a review of best practice examples from current literature, a number of recommendations regarding thermally comfortable park design have been compiled. Although the recommendations are aimed at improving thermal comfort in Windsor's parks, most of the recommendations are generalized and can be applicable for cities throughout Canada.

1. Complete a thermal comfort inventory for all of Windsor's parks

The first step in preparing to improve the design of city parks is to complete a detailed park inventory. This task would include looking at each city park and observing the type and amount of vegetation present, the amount of shade provided, whether or not there is a built shade structure present, the types of materials used in play structures and paved areas, whether or not there are water features present etc. By completing a detailed inventory, Windsor staff can assess the current status of parkland, and be able to make decisions on what needs to be done to help improve thermal comfort. A park inventory could also include observing who is using the park most, which areas in the park have the highest activity, and the socio-demographic factors of the surrounding community. Using this information will allow city staff to identify which parks have the greatest risk, and prioritize which park requires immediate action.

2. Implement thermally conscious design features into new and existing park design

Vegetation

It is apparent that vegetation not only reduces heat in parks, but also reduces the impact of UHIE and climate change in general. Therefore, an inherent recommendation would be to increase the amount of vegetation in city parks. As mentioned previously in the literature review, trees are the most effective at reducing temperatures and providing shade. Depending on the location, native species should be chosen that are fast growing and have low allergenic potential. Although trees are considered the most beneficial at reducing UHI, all forms of vegetation can be useful when trying to reduce environmental temperatures. To help increase local biodiversity, naturalized areas consisting of multiple plant species can be incorporated into park design. Naturalized areas are an effective way to increase vegetation coverage while reducing the need for maintenance. These areas require less up-keep, and need minimal chemical treatment to maintain plant health resulting in better time management and reduced cost. Another option that will help improve thermal comfort in parks is the implementation of community gardens. Community gardens increase vegetation coverage, but will also have a positive impact on the local population, by encouraging residents to participate in planting and maintenance. Increasing vegetation cover will decrease park temperatures, but will ultimately provide benefits for the entire community.

Built Shade Structures

Using built structures to provide shade in parks is another option available to design teams that will help improve thermal comfort. Different constructed options are available (as shown in Table 2), and can serve for multiple uses other than just providing shade (refer to literature review). Constructed shade is extremely useful when trying to provide comfortable resting areas for patrons and shade around sports fields for players and spectators. In order to design a park with optimal thermal comfort, it is recommended that both natural and built shade be used in park design.

Festival Plaza in Windsor would benefit greatly from the implementation of a built shade structure, and would also provide an excellent opportunity to test the effectiveness of built shade devices. Festival Plaza is a public park located in the north area of the city along the Detroit River. The site includes a large outdoor stage facility, making it an ideal location for festivals and concerts. It is a high activity area, but offers little when it comes to shade and a thermally comfortable environment. Ideally, a permanent built shade structure would be constructed, starting from the front of the stage, and extending out, covering the majority of the crowd area (refer to Figure 7). Installing this type of shade device will provide a cooler environment for patrons, allowing them to enjoy community activities without being at risk of harmful UVR and heat related illnesses.

Figure 7: Images taken at Festival Plaza (a), demonstrating the minimal shade provided on site, compared to images taken of the Molson Amphitheatre (b), Toronto ON, demonstrating the permanent shade structure built over the seating area.

(a)

(b)

Water Features

As described in the literature review, the presence of water in a park can positively influence the park's microclimate. Water fountains and other aesthetic features improve environmental cooling through evaporation, while splash pads and sprinklers can act as a cool down area for younger children. Incorporating water features into a park design will lead to a more comfortable park environment.

Cool Material Options

Materials that are used in parks and playgrounds can play a significant role in park temperatures and level of thermal comfort. Some of these materials include asphalt and other paving materials, and rubbers, plastics and metals used to construct play structures. Asphalt is commonly used to pave walkways and parking lots. Its low albedo and emissivity mean that this material has high heat retention, resulting in high surface temperatures. Measurements made throughout the parks in Windsor showed that on a sunny day, unshaded asphalt can reach temperatures above 50ºC. High surface temperatures found in park materials can lead to uncomfortable park environments.

Example of a natural playground (Source: Natural Playground Company, 2009)

There are certain materials that can be used in park design that retain less heat and have lower surface temperatures. Cool pavement options include using permeable asphalt or concrete, whitetopping, and using pavement aggregate to increase reflectivity. For play structures, materials such as metal and plastic can be replaced with natural materials such as wood. That being said, safety concerns need to be addressed when constructing playgrounds making it more challenging when trying to create a thermally conscious design. The Natural Playground Company designs playgrounds that mimic natural environments and use all natural products (Natural Playground Company, 2009). Options similar to this are available, and if used, may help in lowering park temperatures during the summer months. (More information on natural playgrounds can be found at http://naturalplaygrounds.com/index.php).

3. Implement goals and policies to support temperature reduction initiatives

When trying to improve park design throughout a city, setting specific goals and milestones will help maintain motivation and ensure success. For example, the City of Toronto has made efforts to increase the number of trees found on both public and private land in order to double their tree canopy coverage by 2050 (TCPC, 2010). Similar goals can be easily set in

Windsor and other Canadian cities. Pairing certain objectives with supportive policies and/or bylaws will have a positive influence on whether or not certain goals are achievable. A tree bylaw is another example that the City of Toronto has implemented aimed towards protecting trees found on both private and public land from unnecessary damage (TCPC, 2010). By setting attainable goals supported by applicable policies and bylaws, improving thermal comfort within city parks will be achievable.

4. Establish internal and external partnerships

Communication and collaboration between departments and divisions within a municipality provides support when trying to introduce new ideas and projects. When the City of Toronto began to develop their action plan aimed towards reducing UVR exposure by increasing shade in public spaces, members from many different areas of expertise participated. Members of public health, forestry, parks and recreation, dermatologists, and a variety of non-governmental organizations formed a working group. Using a multipronged approach, the working group members collaborated to successfully produce and implement the 2010 Shade Guidelines (Moazami, 2013). By forming partnerships and using the knowledge available from differing departments can help strengthen and motivate the need for improved thermal comfort design in parks.

5. Encourage heat-health related community outreach and public education projects

The best way to avoid any illness or bodily damage related to heat stress or high temperatures is prevention. The Health Unit in Windsor has developed a heat alert system that warns local residents when temperatures and humidity levels are predicted to be above 40°C. This system was put in place since extremely hot weather events are occurring more frequently, and that this type of weather can pose as a threat to the residents in the community. *Stay Cool Windsor-Essex* provides the community with tips on how to stay cool during extreme heat events, provides descriptions and symptoms of heat related illnesses, and provides locations in the city where residents can go to cool down (Stay Cool Windsor Essex, 2012). More information about the *Stay Cool Windsor-Essex* initiative can be found at http://www.staycoolwindsor-essex.com/.

The public consultation questionnaire that was distributed to participants included questions regarding park use throughout the summer. 81% of participants said that their use of Windsor's parks increases during the summer months, despite extreme temperatures and humidity levels; residents spend more time outside during the summer due to nicer weather conditions, organized sports etc. When asked if they were aware of Windsor's *Stay Cool* campaign, 80% of participants responded "No". Although proper park design is important for improving thermal comfort, residents should be aware of the places they can go to cool down during extreme heat events. Community outreach should be done to help educate the public about the dangers of extreme heat events, and what can be done to treat or avoid heat related illnesses from occurring.

7.1 SITE SPECIFIC RECOMMENDATIONS

Each of the six parks that were studied were subjected to different elements that influenced the park environment in different ways. Specific recommendations aimed to improve the thermal comfort in each individual park were compiled based on the research and site level analysis.

7.1.1 Wigle Park

Provide shade over sitting areas

The southern area of Wigle Park consists of a soccer field, making it difficult to incorporate any natural or built shade structures. Despite this, it is recommended that shade be provided for both the player's benches, and spectator areas. Since soccer is a high activity sport, participants are physically exerting themselves, which can be dangerous during extreme heat events. Establishing either natural shade using large trees, or built shade, which can be either temporary or permanent structures, can provide a cool rest area for players when they are not on the field. If a design team decides to use a built shade structure, it is recommended that a temporary device is used, such as an awning or shade sail. A temporary structure can be installed at the beginning of the summer, and removed during the winter months to help avoid damage or vandalism. Another benefit of using a temporary structure is that it can be moved throughout the summer to accommodate the location of the sun. A similar solution can be used for the spectator's bench.

7.1.2 Meadowbrook Park

Install a splash pad or sprinkler system

Meadowbrook Park offers very little when it comes to providing a thermally comfortable environment. Young trees are planted along the walkway, but are not yet big enough to help reduce park temperatures. Since the surrounding community is mostly residential, it is recommended that a splash pad or sprinkler system be installed for the local children. A splash pad offers an option for children to increase their physical activity, while keeping cool during the summer, especially in a relatively unshaded park such as Meadowbrook.

Provide additional shaded sitting areas

More benches and picnic table should be incorporated into park design to provide more rest areas for parents and guardians who are supervising children. Younger trees that do not provide enough shade should be compensated for by implementing temporary shade structures. The goal of using these structures would be to provide adequate shading for park users until the trees are large enough to do so.

Implement 'screen planting' technique along busy roadway


Example of screen planting

Because Meadowbrook Park is located beside a busy roadway, it is recommended that tall shrubs or bushes be planted along the west fence of the park. This strategy is referred to as screen planting: a type of landscaping technique used to screen an area increasing privacy, blocking views, and creating a natural wall-like structure (Harris, 2004). Incorporating screen planting into Meadowbrook park design would block unsightly views of the busy road, reduce noise levels in the park caused by traffic, and increase the amount of vegetation coverage which will ultimately lead to lower park temperatures.

Install a permanent shade structure over play area

The rubber surface of the play structure can have a negative impact on the level of comfort in the park since it can reach temperature up to 60.5°C (Figure 6). Because of this, it is recommended that a permanent built shade structure is placed above the play structure and rubber surface. This will reduce the amount of sunlight and heat that is retained by the rubber surface, and also protect the children using the structure from UVR.

7.1.3 Optimist Memorial Park

Provide shade over sitting areas

Optimist Memorial Park is an excellent example of how vegetation can improve a park environment. The naturalized area in the park reduces temperatures, and mature trees and built structures provide shade for park users. It is recommended that although most of the player's benches are shaded by built structures, the spectator areas should also be shaded. Similar to Wigle Park, temporary shade structures should be used during the summer and removed during the winter months to help prevent damage.

Use cool pavement options

Optimist Memorial has a basketball court on site, as well as two large parking lots. This is an excellent opportunity for designers to employ permeable pavement options that will help reduce the temperatures of these surfaces. The temperature of the basketball court and parking lot area were measured to be 44.0°C and 43.7°C respectively. Using materials that have a higher albedo and permeability will help reduce these surface temperatures and have an overall positive impact on park comfort.

Increase shade around parking lots

Another option that can be used to help reduce parking lot temperatures is to plant vegetation throughout the area. This can be referred to as 'greening a parking lot'. By planting large trees that cast shade over parking areas, and adding islands that support plant growth can reduce parking lot temperatures, and increase the vegetation coverage in the area. This strategy is not limited to parks, but can be used for parking lots throughout the city.

7.1.4 Captain John Wilson Park

Provide shade over sitting areas

Before the construction involving the new play structure and splash pad during the summer of 2013, Captain John Wilson Park offered very little in terms of a thermally suitable park environment. The new design will undoubtedly improve the level of comfort in the park, and will attract more users. In order to accommodate the presence of more park users, more resting areas should be placed throughout the park. Young trees are currently planted along the park walkway, but are not mature enough to provide adequate shading. Permanent shade structures should also be placed over picnic areas, allowing families and other patrons to rest in a shaded environment while using the new facilities.

Install a permanent shade structure over play area

A permanent shade structure is already planned to be added to the new play structure design. This structure will cover the play structure, as well as the rubber surface underneath. This plan will reduce the amount of heat that is retained by the rubber surface, as well as provide added protection for park users.

7.1.5 Jackson Park

Reduce maintenance by planting naturalized gardens

Being a regional park, Jackson Park is relatively large and offers a wide variety of services and facilities to the public. Since it is a regional attraction, the park is usually busy and requires a lot of maintenance. One option would be to incorporate naturalized gardens consisting of native species to help reduce the need for maintenance. Species that are native to the Windsor area will require less watering, and pesticide and fertilizer application. A naturalized garden will require less pruning as well, lowering the amount of maintenance needed.

Install a splash pad and shade over sitting areas

Similar to the recommendations provided for the other parks, it is recommended that the sports area in Jackson Park has temporary shade devices placed over both the player's and spectator's benches. Large trees and permanent shade structures provide adequate shading throughout the majority of the park. A splash pad or sprinkler should be included in the park design, providing younger children an area to cool down in during extreme heat events.

7.1.6 Ford Test Track

Provide cooling options for both players and spectators

The Ford Test Track is a large sports park; therefore, it is hard to accommodate shade structures, water features, and any other strategies that may improve the thermal comfort of users. Since this is such a busy park that is used often by the community, especially during the summer months, efforts should be made to help reduce park temperatures. Shade structures should be used for both the player and spectator's sitting areas. It is recommended that the city provide park users the option of renting temporary, portable shade devices, such as umbrellas or tents that can be used while on site, and then returned to storage once the soccer or baseball game has finished.

The intensity of the UHIE in Windsor, ON is increasing, as are the impacts associated with extreme heat events. Higher temperatures are causing a decrease in thermal comfort public spaces, especially urban parks. Although thermal comfort can be hard to quantify, specific steps can be completed to help ensure that park environments are suitable for the majority of Windsor residents. By completing a park inventory, employing thermally conscious design features, implementing appropriate objectives and thermal comfort policy, forming internal and external partnerships, and continuing community outreach and public education, the City of Windsor can improve thermal comfort in all city parks.