Lake Forest Park Climate Action Plan - DRAFT March 3, 2023

There should not be more than five members of the committee working on this document at any given time, except during scheduled meetings of the committee.

I. Table of Contents

II. Executive Summary

Vision
Lake Forest Park will be a net zero greenhouse gas (GHG) emissions community that expediently and proactively incorporates just, safe, and livable adaptations to climate change impacts, as informed by input from all who live here.

Goals:
To move toward this vision, we have three guiding goals:

1. Reduce and/or limit greenhouse gas emissions (GHG) produced by LFP government, residences, and businesses to meet K4C emissions targets of 50% reduction of 2007 levels by 2030 and 80% by 2050.
2. As a community, develop resilience and adaptive strategies for residents, especially vulnerable populations, to thrive while experiencing the impacts of climate change.
3. Build resilience and adaptive strategies to protect and restore our local forest, river, and park ecosystems as a means to increase CO_2 sequestration and enhance the quality of life for Lake Forest Park residents.

III. Introduction

Lake Forest Park has a stated vision of promoting sustainable living and environmental protection. The 2015 City of Lake Forest Park Comprehensive Plan, ratified in 2016, and the (2008) City of Lake Forest Park Legacy 100-year Vision statement ratified in 2008 both promote values [1]

> The Comprehensive Plan and Legacy Vision share a common vision of sustainability and environmental preservation. The Legacy Vision identifies a number of specific green infrastructure projects that could be implemented over time to achieve this vision. The Comprehensive Plan recognizes and incorporates the importance of environmental preservation in all elements of the plan and highlights specific green infrastructure projects identified in the Legacy Vision next to applicable goals and policies. Together, the Comprehensive Plan and Legacy Vision seek to promote, enhance, and preserve the City's long-term environmental quality and green character. [1]

[1] Lake Forest Park Comprehensive Plan update 2015, p 9 https://www.cityoflfp.gov/160/Lake-Forest-Park-Comprehensive-Plan

Commented [1]: I like the idea of having the adaptation piece in the vision as well as the mitigation (net zero)

Commented [2]: Correct date? Is this the 2008 LFP Climate action plan?

Commented [3]: Put a link (or footnote) to each of these document seperately

The biggest threat to this vision is climate change.

What is climate change?

Climate change is the long-term shift in temperatures and weather patterns, which creates impacts disrupting the balance of life regionally and globally. Climate shifts occur naturally but in the last 150 years human activities have been the main driver of climate change. Human burning of coal, oil, gas and other fossil fuels, deforestation, and large-scale agriculture are responsible for the release into Earth's atmosphere of unprecedented levels of heat-trapping greenhouse gases (GHG) including carbon dioxide and methane. The resulting increase in global temperature causes many severe risks to human beings and all other forms of life on Earth. (United Nations, IPCC)

Climate change threatens human survival, health, and quality of life. It erodes the world's interconnected ecosystems, of which humans are a part. Different locations experience climate change in diverse ways. Locally in the Pacific Northwest, and specifically in Lake Forest Park, we are especially vulnerable to:

- heatwaves
- drought
- wildfires
- air pollution from wildfire smoke
- increasingly violent weather and storms
- increased flooding, including groundwater flooding
- changes in winter precipitation to increased rain and decreased snowpack
- faster and more sudden spring thaws
- change in USDA hardiness zones
- sea level rise
- ocean acidification
- flora/fauna changes
- pests disease

Each of these changes leads to a cascade of potentially devastating impacts at individual, community, ecosystem, and economic levels.

Climate change action is urgent. Our world is experiencing rapid changes. In order to reduce and prevent ~~the~~ current and future harm, we must react immediately to disseminate information, collaboratively decide on actions to reduce our individual and community actions that drive global warming, improve our ability to react to current and future impacts to ourselves and to our surrounding ecosystems, and build community resistance through which we can work together without leaving anyone out.

> "While cities need to focus on financing, designing, and implementing near-term adaptation strategies, many of these important efforts simply cannot address long-term threats….Even so it's time we desperately need while the world gets its act together to

Commented [4]: Does this sound like hyperbole, in this context?

Commented [5]: I think we should expand on this and possibly separate out the specific impacts that fall under it?

Formatted: Font: (Default) Times New Roman, Font color: Auto

Formatted: Space After: 0 pt

achieve carbon neutrality and develop longer term plans for comprehensive solutions. There's a finer lesson here too, which is that cities will have to continually make decisions about where and how much to invest in the face of a great deal of uncertainty."[2]

IV. Background:

City of Lake Forest Park actions on climate change

The first formal action of the city of Lake Forest Park to address climate change was a 2008 climate action plan written by Emily M. Templin at the Evans School of Government at the University of Washington. Due to the recession that year, the plan was shelved and no concerted actions were taken by the city.

The City of Lake Forest Park voted to join the King County Cities Climate Collaborative (K4C) in 2019, with the stated commitment to reduce city produced greenhouse gas emissions to 50% of 2007 levels by 2030 and 80% by 2050.

In June 2022, the Lake Forest Park City Council unanimously voted to create The LFP Climate Action Committee with the mission to design a Climate Action Plan guiding the means by which the city will reduce GHG emissions and increase community resilience to climate change impacts.

The committee was specified to include eleven residents, two of whom should be students, confirmed by the LFP city council.

Mission - from LFP website:

The Climate Action Committee will:
gather and analyze climate information and draft a *Climate Action Plan* for recommendation to the City Council. The Committee's initial responsibilities are:

- Prepare a first-year work plan, supporting the creation of a *Climate Action Plan*
- Draft a *Climate Action Plan* for Council consideration. The tasks associated with the draft of the *Climate Action Plan* would include:
  - Review of existing local municipal climate action plans to identify best practices
  - Review and recommend changes to City operations to address climate change
  - Identify potential additions and amendments to legislation and community projects in support of a *Climate Action Plan*
  - Interaction with City commissions, committees, boards, and task forces
  - Identify potential funding sources to achieve the *Climate Action Plan* goals financially

Summary of Lake Forest Park residential demographics

Summary of Lake Forest Park strengths to create resiliency, mitigate GHG

Unique city 40 % tree canopy cover, adaptability

Commented [6]: City adopted this document

Commented [7]: Is this the whole mission?

Commented [8]: Check this?

Commented [9]: double check this - Cory will send ordinance

Commented [10]: TRACY Heat map, flood map, vulnerable areas KC flood control district basic demographics, renters, age,

Close knit community

Moved here because of the tree canopy/yard

Streams act as conduit where people come together. Lakes and streams are cooling factors

Migratory birds, and other animals habitats

Engaged community

resident expertise

Energy use profile for Lake Forest Park (short segment for this background section? and put more technical aspects in a later section?)

had looked at the 2008 Climate Action report, the King County Climate Action Toolkit and the King County 2022 Emissions study.

V. Lake Forest Park emissions data

The City of Lake Forest Park has a set of emissions data that was generated by K4C. It's no surprise that the two major sources of emissions are from our transportation sector and from our building sector. The other major sources of emissions are consumption and disposal mostly around issues of recycling in the landfill. Another area is the maintenance of our streams and forests as places which provide carbon sequestration. The K4C report also attributes significant emissions to air travel. The Lake Forest Park portion is based on the typical number of airplane trips divided by the number of people in King County based on income.

Emissions reductions will come from a variety of places. Some emissions reductions come from individual actions, including: putting in heat pump, buying an EV, planting more trees, driving less, putting in solar panels. Other reductions come from policy decisions made on the county, state or federal level such as fuel economy standards, the decision to buy electric buses for public transportation all of which contribute to emissions reductions.

Lake Forest Park, and all the other cities in King County as well as the county itself, the state government and the federal government all contribute to the reduction of emissions. Below you'll see what it's called the wedge diagram. This diagram is intended to look at three alternatives to what happens with forecasted emissions.

- The first scenario is what would happen if no action were taken.
- The second scenario identifies the emission reductions that are anticipated from actions that the federal, state and county policies are implemented.
- The third scenario includes all of the local actions taken by cities and other districts to reduce local emissions.

This diagram helps the city focus on the responsibilities of the city and its residents.

Commented [11]: include summary charts

Commented [12]: Include just data here. Take out actions --> put elsewhere.

Commented [13]: Rephrase?

Commented [14]: Should we call out agriculture as well, specifically consumption of meat?

Commented [15]: Would like to see a statement here about that this is NOT the only consumption-based source of emissions - there are emissions associated with the manufacture and use of the product.

Commented [16]: not sure what this means

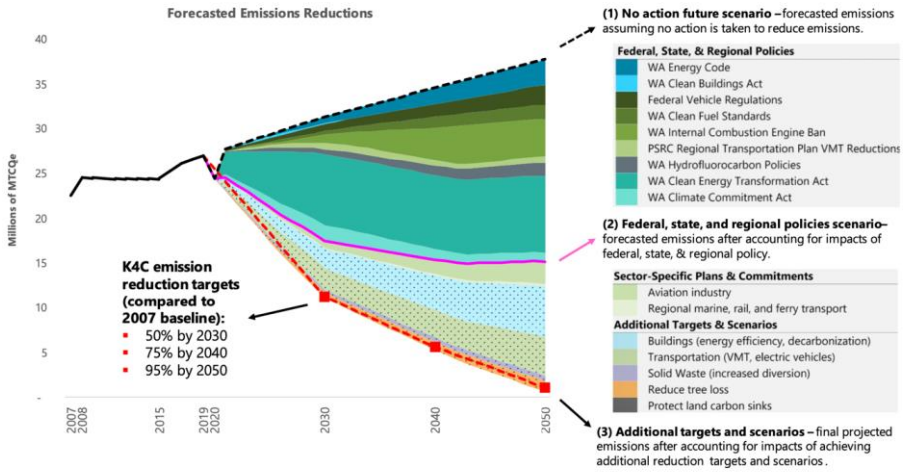
Commented [17]: this is getting into consumption vs geographic emissions

Commented [18]: verify

Commented [19]: Emphasize a majority?

Commented [20]: Perhaps the wedge diagram should be simplified so that all the transportation-based emissions are one color, home heating-based emissions are another color, and everything else is a third color.

Figure 5. Forecasted emissions and reductions under three scenarios.



[2]

check source.

The chart below is the emissions of greenhouse gasses by sector for Lake Forest Park in 2019. The study was done by Cascadia Consulting check source for every city in King County. In Lake Forest Park, the largest portion of emissions are from transportation. Thirty-one percent is from on road vehicles—cars, trucks, busses. Another six percent is from off-road include construction equipment, jet skis, ATV's riding lawnmowers..

The second largest portion of emissions is from built environment. This is represented by 21% of the city's total emissions. Energy used in buildings is the second largest source of greenhouse gas emissions in the city of Lake Forest Park. Most of these emissions come from natural gas or heating oil for homes and buildings. Seventy-five percent of Lake Forest Park households have a connection to gas either for heating or cooking.

Lake Forest Park gets its electricity from Seattle City Light. Seattle City Light is carbon neutral because it generates electricity from carbon neutral sources mostly hydropower. As the city's maps out the future planning the focus should be on switching from natural gas and oil to electric heat pumps. The Inflation reduction Act provides incentives for homeowners. Heat pumps have the advantages of providing air conditioning, lowering the cost of heating and reducing indoor air pollution.

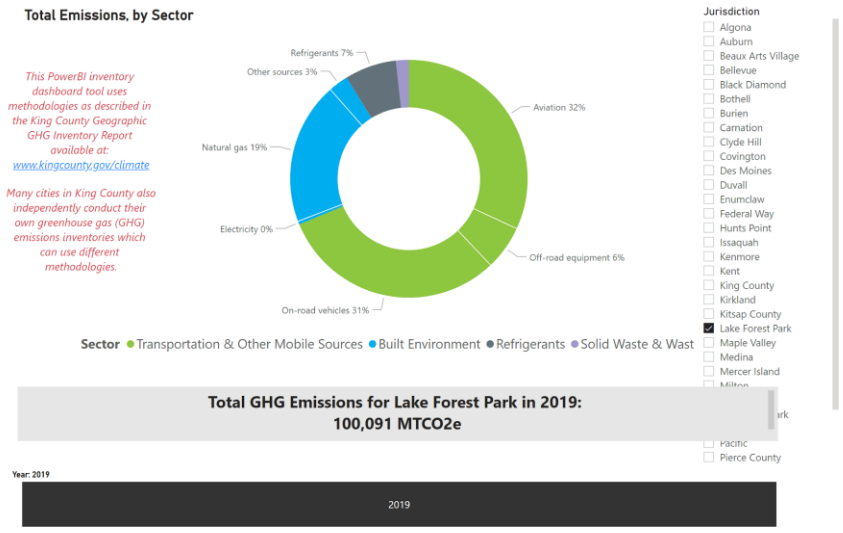
The City of Lake Forest Park could set new emission standards for new construction and provide incentives to electrify the city. Kirkland requires all new homes to have roofs that can accommodate solar installations.

Do these emissions include pass though transportation from cars passing through the city? What about Metro transit, school busses?

[2] Check source king co

Commented [21]: A home can have a heat pump and also a gas fireplace for heat in the event of a power outage. How can we incentivize people to switch from a gas stove to electric? I think we need to address that people may want to keep their gas stoves/fireplaces so they can cook food/stay warm during a power outage.

Commented [22]: Does this make sense for every new housing



This report will include:

- what an individuals can do in their households and
- what policy changes should be implemented by the city government for municipal operations and
- a policy framework for the reduction of emissions by businesses and homeowners.

In shaping this report, we want to look at three things, how can we make a resilient city, how to ensure that the actions do not impact disproportionately the most vulnerable members of our community, and how can we make the appropriate mitigations and adaptations.

in 2008 the city developed its first Climate Action Plan. It focused on activities the city government could do.

The purpose of this report- the Lake Forest Park (LFP) Climate Action Plan (CAP)- is to

Commented [23]: Heading and mitigation adn resilience
and climate justic

Quick brief on 2008 plan and actions completed

recommend actions that LFP can take to reduce greenhouse gas emissions. The two steps taken to complete the CAP follow:
1. Completed a municipal and community greenhouse gas (GHG) emission inventory
2. Developed a suite of potential greenhouse gas reducing actions at the community and municipal level. [3]

Here is some information on the below, we can chat on this later this evening if you have additional questions. Cory provided this list in blue.

- Lights out – Reminders to turn lights off are posted or lights are on timers. Most CH lights are now LED, plan to convert remaining are in the works.
- Computers off – Computers are turned off or go into energy saving mode.
- Energy Audit – Do not think so.
- HVAC Maintenance – Maintenance and upgrades happen throughout years, HEPA filters are used.
- Energy Star Appliance Acquisition – Yes, new appliances replaced are energy efficient.
- Solar Panel Installation – No, currently not feasible. Sites may be investigated for future viability.
- Limits on vehicle Idling – There has been a policy implemented.
- Fuel Efficient Vehicle Purchase – First EV is planned for purchase this year. Most of our handheld equipment is changing out to battery powered (blowers, mowers, chainsaws, etc.).
- Alternative Transport Incentives – Bike to work month.
- Recycling Programs Expansion – Yes.
- Implement Environmental Purchasing Program – Not sure what this would be.

Add proposed community actions.

Commented [24]: what is this policy and how is it enforced?

VI. Community Priorities

Commented [25]: Move this section to after (VII energy and buildings)

The climate action committee developed a survey of 40 short answer questions to give the residents a voice in the climate action process. The survey was designed by the Lake Forest Park climate action committee and distributed at the farmers market and to 39 other groups in the city including newspapers, mailing lists that we were able to obtain, including PTSA, Facebook groups, apartment complexes, and municipal mailing lists.

The survey was available from August to December 2022, and we had 446 responses.

Major takeaways

- The community cares very much about climate change.

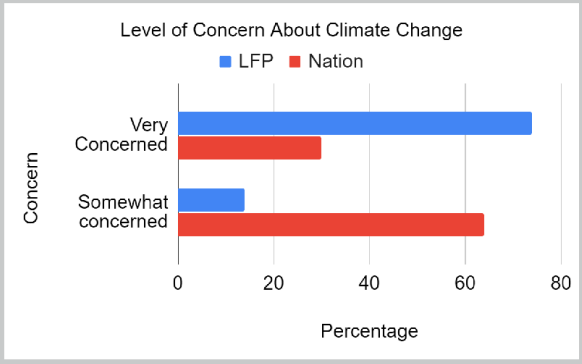
[3] Lake Forest Park Preliminary Greenhouse Gas Inventory and Proposed Climate Action Plan, *Emily M. Templin, page 6*

- Individuals in the community gather climate information from many different sources
- LFP should partner with neighboring cities as we address climate issues (good example is Energysmart eastside)
- Short answers inform education and outreach efforts

The community cares very much about climate change

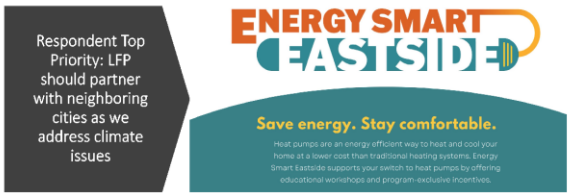
- 88% of LFP survey respondents are either very or somewhat concerned
- 94% of Americans* are either very or somewhat concerned
- Larger percentage of people who are 'Very Concerned" in LFP vs. Nation.
- others not concerned

*Yale Climate Communication Survey in July 2022



Individuals in the community gather information from many different sources

The range is from scholarly journals, newspapers, the internet in general, some specific climate organizations. On the internet Facebook, Twitter and Instagram make up 69% of the internet responses. Other sources include Buy Nothing, King County, Next Door, Reddit, TikTok, LinkedIn and Snap chap. A few responses are from TV, climate action and policy sites and gardening groups



We can utilize strategies or actions like those listed below to reduce our community's contribution to climate change. Do you think our city should make these strategies a high, medium or low priority?
Of the 15 Strategies presented on the survey

3 Most popular
Partner with other cities to influence climate friendly policy changes (59% high priority)
Transition to non-fossil fuel transportation (electric vehicles, biking, etc.) (56% high priority)
Inform residents about existing incentives/subsidies

To reduce carbon emissions from transportation Lake Forest Park needs to focus on four strategies.

Commented [26]: do these derive from survey results or are we starting a new section?

Drive Less through Safe Streets Program to encourage walking and biking, residents need to feel that the streets are safe for them and their children.

Move To Electric Vehicles-
Over the course of the next several years the city's municipal fleet needs to become all electric. The city needs to work on developing infrastructure for electric vehicles including charging stations. Support the educational opportunities for electrification of vehicles.

Support Transit
King County metro is committed to expanding its fleet to non-fossil fuel. The city needs to figure out ways to encourage the use of transit by its residence. suggestions have included of course the park and ride lot but also ~~uh~~ jitneys that might pick up people or expanding the use of Uber and Lyft to get people to transit hubs.

Build for the Missing Middle
Prioritize dense mixed-use transit oriented development and affordable housing (language from Kenmore CAP, p 23)

VII. Energy and Buildings

Mandate New Green Building Codes
Require new buildings to have electric heating, cooling and cooking.
Require new residential buildings to be fitted for solar (see Kirkland ordinance)

Retrofitting Existing Buildings
Encourage residents to plan for the retrofitting of their personal buildings. This means planning for new heat pumps, electric stoves and electric heating. The city needs to collaborate with other North End cities to provide incentives for electrification.

VIII. Recycling

Increase composting and recycling
Provide expanded education on what can go in various bins in residential recycling and composting. Work with Republic Services to focus on multifamily, schools and businesses to ensure proper composting and recycling.

Examine the Republic contract when the 2018 contract renewal comes up make sure it provides mandatory recycling and composting and encourage the provider to move from natural gas vehicles to electric vehicles.

Evaluate commercial recycling and composting.
Ensure that commercial and restaurants our actually composting and recycling.

Support the Lake Forest Park Farmers Market as a source of sustainable local food.

IX. Canopy and water resources

Tree Canopy Importance in Lake Forest Park (taken from 2011 Tree Board Report)

Climate Change is an issue of global concern. Urban trees can help mitigate climate change by sequestering atmospheric carbon (from carbon dioxide) in tissue and by altering energy use in buildings, and consequently altering carbon dioxide emissions from fossil-fuel based power plants.

Understanding an urban forest's structure, function and value can promote management decisions that will improve human health and environmental quality. The urban forest of Lake Forest Park has an estimated 207,000 trees with a tree cover of 42.4 %.

The urban forest can help improve air quality by reducing air temperature, directly removing pollutants from the air, and reducing energy consumption in buildings, which consequently reduces air pollutant emissions from the power plants. Trees also emit volatile organic compounds that can contribute to ozone formation. However, integrative studies have revealed that an increase in tree cover leads to reduced ozone formation.

Pollution removal by trees in Lake Forest Park was estimated using field data and recent pollution and weather data available. Pollution removal was greatest for O_3. It is estimated that trees remove 32 tons of air pollution (CO, NO_2, O_3, PM10, SO_2) per year with an associated value of $162 thousand (based on estimated national median externality costs associated with pollutants.

Trees reduce the amount of carbon in the atmosphere by sequestering carbon in new growth every year. The amount of carbon annually sequestered is increased with the size and health of the trees. The gross sequestration of Lake Forest Park trees is about 1,810 tons of carbon per year with an associated value of $33.4 thousand. Net carbon sequestration in the urban forest is about 1,580 tons.

As trees grow, they store more carbon as wood. As trees die and decay, they release much of the stored carbon back to the atmosphere. Thus, carbon storage is an indication of the amount of carbon that can be lost if trees are allowed to die and decompose. Trees in Lake Forest Park are estimated to store 47,700 tons of carbon ($879 thousand). Of all the species sampled, Douglas fir stores and sequesters the most carbon (approximately 38.1% of the total carbon stored and 26.3% of all sequestered carbon.)

Trees affect energy consumption by shading buildings, providing evaporative cooling, and blocking winter winds. Trees tend to reduce building energy consumption in the summer months and can either increase or decrease building energy use in the winter months, depending on the location of trees around the building. Estimates of tree effects on energy use are based on field measurements of tree distance and direction to space conditioned residential buildings.

Based on 2002 prices, trees in Lake Forest Park are estimated to reduce energy-related costs from residential buildings by $120 thousand annually. Trees also provide an additional $2,873 in value by reducing the amount of carbon released by fossil-fuel based power plants (a reduction of 156 tons of carbon emissions).

Urban forests have a structural value based on the trees themselves (e.g., the cost of having to replace a tree with a similar tree); they also have functional values (either positive or negative) based on the functions the trees perform.

The structural value of an urban forest tends to increase with a rise in the number and size of healthy trees. Annual functional values also tend to increase with increased number and size of healthy trees and are usually on the order of several million dollars per year. Through proper management, urban forest values can be increased; however, the values and benefits also can decrease as the amount of healthy tree cover declines.

Still to come….Comparison between 2010 report and 2023 which is coming out in June. How do the reports compare in terms of tree canopy cover? Increasing? Decreasing? Will we be able to discern which areas in LFP are changing the most?

My own iTree Canopy analysis (still developing) shows a higher percent of canopy cover in LFP than the tree board report.

Symptoms of Climate Change on Urban Trees

Increased CO_2 levels and warmer temperatures may initially promote urban tree growth by accelerating photosynthesis, but recent studies suggest that continued warming in the absence of adequate water and nutrients stresses trees and inhibits future development. Regional climate projections suggest that plant hardiness zones in the Salish Sea region are likely to increase by a half zone towards the end of the century (Kim, et al. 2012). The bioclimatic conditions that make up the current seed transfer zones around the Salish Sea for western redcedar, western hemlock, and Douglas-fir are likely to diminish, shift further northwest, or disappear by the end of the century.

Warmer winter temperatures increase the likelihood of winter kill, in which trees, responding to their altered environment, prematurely begin to circulate water and nutrients in their vascular tissue. If rapid cooling follows these unnatural warm periods, tissues will freeze, and trees will sustain injury or death.

Warmer winter temperatures favor many populations of tree pest and pathogen species normally kept at low levels by cold winter temperatures. Although climate change may reduce populations of some species, many others are better able than their arboreal hosts to adapt to changing environments due to their short lifecycles and rapid evolutionary capacity. The consequences of these population changes are compounded by the fact that hot, dry environments enrich carbohydrate concentrations in tree foliage, making urban trees more attractive to pests and pathogens.

Climate change alters water cycles in ways that impact urban forests. Increased winter precipitation puts urban forests at greater risk from physical damage due to increased snow and ice loading. Increased summer evaporation and transpiration creates water shortages often exacerbated by urban soil compaction and impermeable surfaces. More frequent and intense extreme weather events increase the likelihood of severe flooding, which may uproot trees and cause injury or death to tree root systems if waterlogged soils persist for prolonged periods.

Especially cold regions may benefit from increased tourism, agricultural productivity, and ease of transport because of climate change. However, the potential positive implications of climate change are far eclipsed by the negative. Rising temperatures, increased pest and pathogen activity, and water cycle changes impose physiological stresses on urban forests that compromise forest ability to deliver ecosystem services that protect against climate change. Climate change will also continue to alter species ranges and regeneration rates, further affecting the health and composition of urban forests. Proactive management is necessary to protect urban forests against climate-related threats, and to sustain desired urban forest structures for future generations.

Solutions to protect/mitigate Urban Trees from Climate Change

The strategy of using nature as a defense against climate impacts is called ecosystem-based adaptation (EbA) which has been endorsed by the United Nations Environment Program (UNEP). A large contributor to the strategic plan of EbA involves the restoration and protection of Urban forests.

In 2006, California used aerial photography to reveal potential sites for planting individual trees in the 21 cities considered (McPherson and Simpson 2003). If planted strategically to shade east and west walls of residential buildings, they would reduce energy use from air conditioning in the summer months. Deciduous trees, planted on the south and west sides, will keep your house cool in the summer and let the sun warm your home in the winter, reducing energy use. Trees or shrubs planted to shade air conditioners help cool a building more efficiently, using less electricity. A unit operating in the shade uses as much as 10% less electricity than the same one operating in the sun (U.S. Department of Energy).

Frontiers in Forests and Global Change (2021) found that forests damaged by insects sequestered 69% less carbon than undamaged forests. Those affected by disease sequestered 28% less carbon. Identifying and containing pests early within a city can avoid massive tree die-off. Government training programs and community outreach programs can be vital initial containers.

Strategies recommended by the scientists to confront damaging forest insects and diseases include:

1. Implementing improved forest management practices, such as ecological thinning to increase the resilience of forests by promoting biodiversity and variations in tree age and spacing.
2. Strengthening policies that prevent additional non-native forest pests from entering the city, including stronger regulations on imported plants for nurseries, and enforcing and improving treatment standards for solid wood packaging materials such as pallets and crates.
3. Promoting “slow the spread” programs such as the ‘Don't Move Firewood’ campaign to reduce the movement of established pests across geographies.
4. Using impact models and monitoring data to anticipate the arrival and spread of insects and pathogens (e.g., goldspotted oak borer, sudden oak death) and prioritize management actions to help limit their spread.

Seattle recently formed the Urban Forestry Core Team (2020) to provide better oversight of their urban forests to facilitate existing policies, programs, regulations, and incentives that are used to manage Seattle’s urban forest and combat climate change. The Core Team meets regularly, and this gives staff opportunities to discuss needs and collaborate on actions that will impact the urban forest. Issues identified by the Core Team are elevated to department directors and the mayor’s office as needed. A similar team may be considered for the city of Lake Forest Park.

Any Urban Forest policy should be constructed as comprehensive considering future populations, commit to race and social initiatives that are proactive in promoting equity and environmental access for all citizens.

Stream Importance in Lake Forest Park

Urban streams are key contributors to climate change mitigation strategies and protecting urban stream environments should be considered high priority in terms of climate resilience and adaptation.

The ecological, functional value of streams in urban environments can be divided into four categories: increase biodiversity, maintain hydrological processes, improve urban microclimate, and promote direct and indirect financial benefits. Many of the biological reasons for protection of streams in the urban environment are also economic and practical since the contribution of streams vegetation to erosion prevention, noise reduction, residents' health and the distribution of the population in a city is linked with economic and social equities.

Urban streams affect the climate by adjusting the humidity and temperature and generally significantly contribute to improving the medium- and micro-climate. Water areas in the city will help even out temperature deviations both during summer and winter. The vegetation associated with streams, known as riparian zones, reduces the temperature of the surrounding area during the summer by shading and evapotranspiration.

Urban streams act as green corridors or natural air vents because they create air flows, thus contributing to the renewal of the air we breathe and the control of pollution in the atmosphere. The riparian zones filter air by holding suspended dust particles induced from the road traffic, the building activities, etc. and they enrich the atmosphere with oxygen. Filtering capacity increases with more leaf area, and is higher for trees than bushes or grassland. Coniferous trees have a larger filtering capacity than trees with deciduous leaves, however, coniferous trees are sensitive to air pollution. Thus, emphasizing a rich diversity of tree types and species in association with riparian zones as measures of climate resilience.

The vegetation and the soil of streams contribute to the retention and infiltration of the rain water and the reduction of the surface runoff which can constitute a significant flood prevention mechanism.

Urban streams are valuable ecosystems hosting a variety of habitats of plant species, birds and animals and facilitate species migration by connected species-rich areas, act as corridors which are suitable for wildlife habitat and migration and can be the tool to mitigate habitat loss and fragmentation and conserve biodiversity. Urban streams with high amounts of intact riparian vegetation exhibited biodiversity levels more comparable to less urban areas despite high amounts of impervious cover in their catchments.

Finally, urban streams offer social values such as recreational use (especially strolling and relaxation), participation, nature and scenery, sanitary management, and water safety as being

important factors relating to public perception of urban stream corridors and greenways. The urban stream ecosystems can provide scientific information and function as indicators of the state of the urban environment. Urban streams are also cornerstone venues for ecological and environmental education. The city of Lake Forest Park should have an obligation to help children to learn about the environment surrounding them and the role urban streams play in the environment and how they are connected and affected by negative impacts on them.

Symptoms of Climate Change on Urban Streams

Urban Stream Syndrome (USS) is the collection of symptoms that urban streams express during climate change. These symptoms include increased magnitude and unpredictability of flows, increased water temperatures, elevated nutrient and contaminant concentrations, and a decrease in the number and variety of plant and animal communities. Many of the effects of climate change on stream ecosystems are indirect via effects on riparian vegetation and canopy structure.

Figure 1 shows the complexity of climate change effects on urban streams, with direct and indirect impacts.

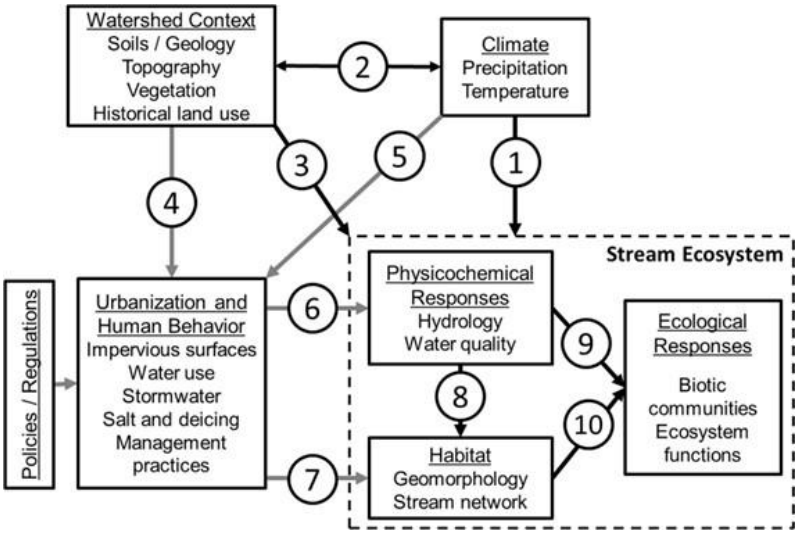


Figure 1. Conceptual model representing pathways of how climate directly (in the absence of human actions, black arrows) and indirectly (e.g., through human actions and watershed features, grey arrows) affects stream ecosystem structure and function. (Taken from Hale, et al., 2015)

Given the complexity of factors that can adversely affect urban stream environments, mitigation of urban streams during climate change should take on a multi-pronged approach.

Mitigation and Protection of Urban Streams with Climate Change

In urban areas, the restoration of streams (i.e., the return to natural conditions) is most often not realistic due to the numerous unavoidable constraints brought by the urban environment (such as population growth, the existence of roads and buildings and other constructions that cannot be removed). Lake Forest Park offers a unique glimmer of hope given our large tree canopy cover and large greenbelts associated with the two main stream basins, McAleer and Lyon Creek Basins. However, unless high priority in preventing further development and disruption of these basins is implemented, Lake Forest Park may concede to the constraints that most other urban areas cannot avoid.

Successful rehabilitation of urban streams can only be achieved once stormwater management and the spatial distribution of water storage are re-established and protected throughout the urban basin. There are five principles for urban stormwater management as proposed by Walsh (2016).

1. Ecosystems to be protected must be identified, and objectives for their ecological state must be set.
2. Prevent significant runoff volumes from reaching the stream so that the interplay between evapotranspiration, infiltration, and streamflow should resemble pre-development conditions.
3. Stormwater control measures (SCMs) should yield flow regimes that resemble the predevelopment regime in both quality and quantity.
4. SCMs should be able to store water from high flow events so that the frequency of disturbance to biota does not increase in comparison with pre-development conditions.
5. SCMs should be implemented on all impervious surfaces in the catchment of the target stream. Examples of SCMs are rainwater tanks, infiltration systems that receive overflow from tanks and impervious surfaces, and biofiltration systems.

Many urban streams are channelized, impacting channel geomorphology and streambed sedimentological characteristics through the reduction of riffle habitat frequency, increased streambed substrate embeddedness, frequency of fine substrate, and streambed siltation. Projects should aim to restore geomorphology through channel rehabilitation. Some channel rehabilitation practices include the replacement of concrete or riprap streambed with a more natural substrate, such as gravel and sand, and, in cases where banks cannot be re-naturalized, the incorporation of engineering-based methods, such as porous concrete that allows the development of riparian vegetation.

Assemblages of benthic invertebrates have been shown to directly relate to the quality of streams and are direct beacons in identifying areas impacted by USS. Monitoring and rehabilitation of macroinvertebrate assemblages should be prioritized as key insights to the effects of climate change. Past studies have shown the Benthic Index of Biotic Integrity analysis (B-IBI) for McAleer and Lyon Creek at “Fair” to “Poor”.

Benthic invertebrates are largely affected by streamflow and diversity of habitats, both of which can be mitigated by maintaining riparian environments. Removal of invasive species and establishing buffer zones for riparian environments should be prioritized.

Another important refuge for benthic invertebrates, especially during early development phases, is the hyporheic zone (Lynch, 2020). This area constitutes a transition between the surface stream and groundwater. The hyporheic helps to regulate a stream's temperature, bringing in comparatively cooler underground water in the hot summer and warmer underground water in the cold winter. It also plays a key role in filtering runoff pollution and providing oxygen to stream benthic environments. In hyporheic studies of Thornton Creek, pollutant concentration from urban runoff has been reduced by 78%. Restoration of stream hyporheic zones have also been key mitigation for salmon recovery programs. Restoration of hyporheic zones in heavily impacted areas should be prioritized and can be done relatively cheaply. Re-seeding healthy benthic invertebrates into restored areas should be researched and considered.

A final mitigation strategy should be the support for reintroducing native kokanee salmonid populations (*Oncorhynchus nerka*) into both Lyon and McAleer Creek basins, as outlined by Lake Sammamish Kokanee Work Group (KWG). Recent evidence suggests that kokanee populations in North Creek and Little Bear Creek in south Snohomish are related to stocks that originated in McAleer-Lyon Creek Basins (Jensen, 2020). It has long been known that Pacific salmon are keystone species and play an essential role in the health and function of ecosystems. Salmon benefit other species as food and their bodies enrich habitats through the cycling of nutrients from the ocean to freshwater streams. There is evidence that creeks that support kokanee populations, are associated with greater benthic invertebrate diversity and overall health scores (Puget Sound Stream Benthos) and may be key to maintaining resilience for climate change.

Any Urban Stream policy should be constructed as comprehensive considering future populations, commit to race and social initiatives that are proactive in promoting equity and environmental access for all citizens.

X. Community wellbeing

Preparing For Climate Emergencies

Identify heating and cooling centers.
Identify roads in lake Forest Park that are vulnerable to flooding and landslides
Create a youth focused strategy for communication and engagement during emergencies
Provide free or discounted air filter box fans to vulnerable community members

XI. Implementation

The Climate action committee sees itself as a critical component in the implementation of the climate action plan. The city of Lake Forest park needs to continue to allocate staff resources to help ensure the implementation of the climate action plan and may require additional resources from other departments we think there are three things that we need to do in terms of oversight

and accountability and those are developing recommendations for programs practices and priorities to make sure that the biennial capital budget includes umm ways to monitor emission reductions and evaluate necessary next steps and prepare some kind of report on an annual basis to the City Council and the mayor

How to approach this section??

XII. Summary (?)

XIII. Useful resources

XIV.Sources Cited

Commented [27]: Haven't recently looked through other CAP models (eg shoreline, Kenmore) - will do this to see what the skeleton of sections is…

---

[1] *Lake Forest Park 2015 Comprehensive Plan Update | Volume I: Goals and Policies, p 9*

[2] **All We Can Save, edited by Ayana Elizabeth Johnson and Katharine K, Wilkerson, One world publishing 2020, page 161.**