Urban Forest Master Plan

What trees do for HRM in our urban environment

“Urban forest can help mitigate problems associated with urbanization and improve environmental quality and human health”

(Dr. D. Nowak)

Existing Municipal Urban Forest Values (Sustainability Values)

Sources of values:

HRM Regional Plan

Open Space Master Plan

HRM By Design

SEMO policy documents

Site-specific master plans

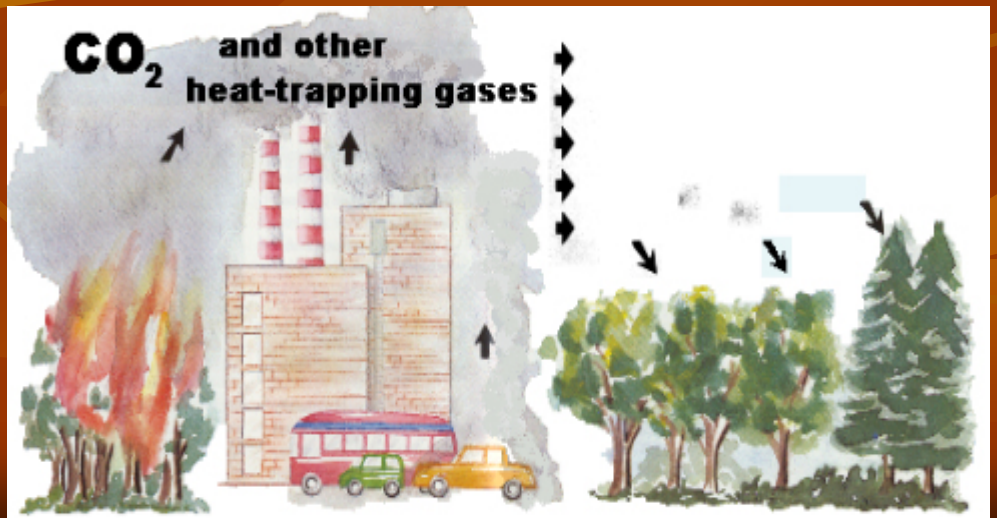
Council focus area statements

Kyoto Accord

Trees filter and clean our air

Why is this of concern?

- Greenhouse effect
- Localized health effects on humans
- Localized negative effects of pollution on the environment



How do trees filter air?

- Primarily pollutant gases are absorbed on the leaf surface, though some gases are removed by the plant's surface area itself.
- Some of the pollutants removed in the air by trees are: nitrogen dioxide, sulfur dioxide, carbon dioxide, cadmium, nickel, lead, ground level ozone.
- Trees remove particulates in the air that are tied to respiratory problems.
- Trees sequester carbon through photosynthesis, carbon is added to their structure as they grow.

"For every ton of new wood that grows, about 1.5 tons of CO2 are removed from the air and 1.07 tons of life-giving oxygen are produced. During a 50-year life span, one tree will generate $30,000 in oxygen, recycle $35,000 worth of water, and clean up $60,000 worth of air pollution or $125,000 total per tree without including any other values!" (**G, Roloff. USDA Forest Service**)

Other studies measure additional values – not single comprehensive values

- Image to scale one tree

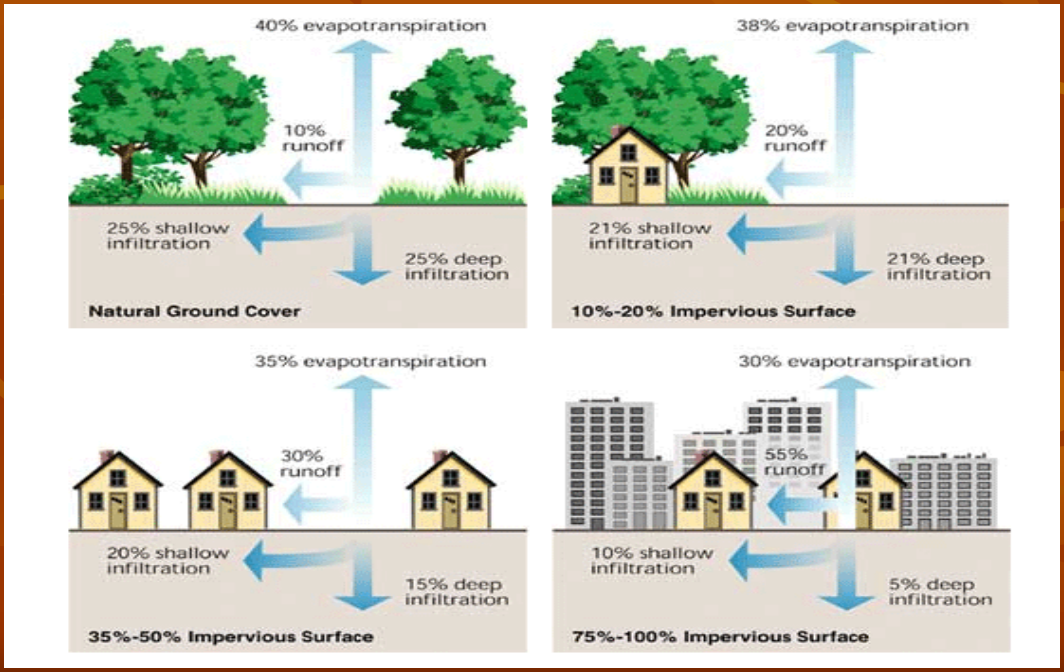
Tree interrupt rain

Why is important to interrupt rain or storm water?

- Trees retain water on site.
- Large rain events can cause sewage treatment plants that are fed by sewer & storm drain combination to become overloaded.
- During heavy downpours rain will carry contaminants such as oil, metals or pesticides into streams, wetlands, lakes, and marine waters.
- Trees intercept rainfall in their canopy, reducing the amount of rain that reaches the ground. A portion of this captured rainwater evaporates from tree surfaces.
- Trees take up water from the soil through their roots, which increases soil water storage potential and lengthens the amount of time before rainfall becomes runoff.

How trees interrupt storm water

- Through their canopy, branch structure and trunk, trees intercept, reduce flow, absorb and transpire large amounts of precipitation (a single tree can interrupt from between 850- 2,400 gallons of water a year).
- Tree roots also hold soil in place reducing erosion issues during storm events.
- Trees absorb the first 30% of most precipitation events.

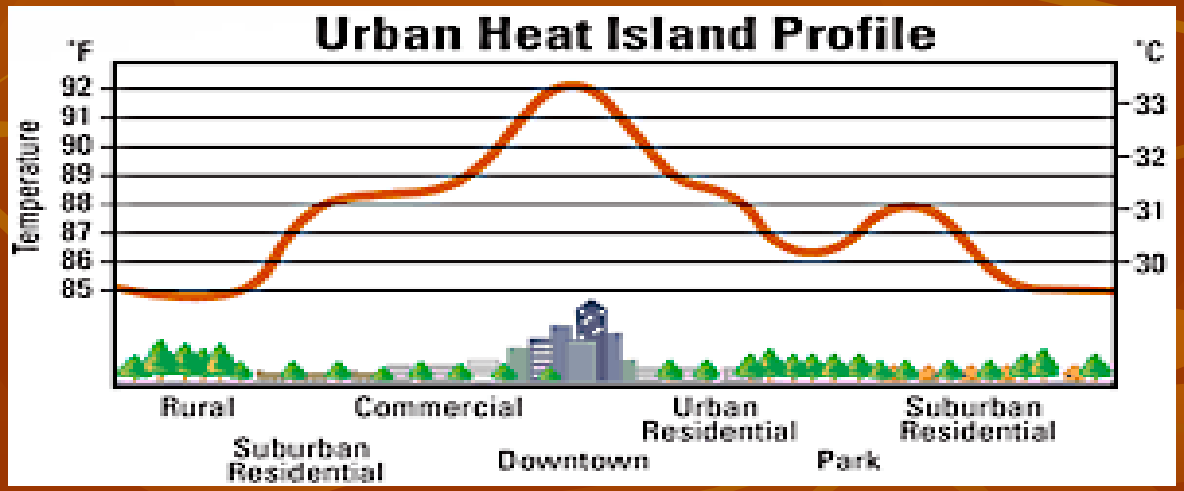


Trees and the reduction of heat

Heat Islands are described as a localized climate modification.

In urban areas this is caused by:

- heat production from human activity (heating, manufacturing, commuting, building, etc.)
- the relative low reflectivity of urban structures causing the absorption and storage of solar heat
- urban wind tunnel effect
- minimal access to water evaporation.



How trees reduce heat

- By shading
- By transpiration: mature trees can transpire up to 100 gallons a water a day (effective as 5 large air conditioners running 20 hr a day)
- By reflection of incoming solar radiation

Reducing Heat Islands

Why is important to reduce heat islands?

- Heat islands can be 1C – 6C warmer then surrounding rural areas
- Human comfort and health
  - In USA more people die because of exposure to excessive heat each year than by hurricane, tornado, floods and earthquakes combined
- Reduction in air pollution (smog, greenhouse gases)
  - 1C – 2C has significant impacts on hydrocarbon emissions (with the increase in pollution there is a corresponding increase in negative impacts on human health)
- Energy reduction
  - 20%-50% saving in summer cooling cost
  - 0.6C increase in temperature increases 1.5% to 2% on peak demand utility demand load

Trees and canopy over parking lots

Why is important to have canopy over parking lots?

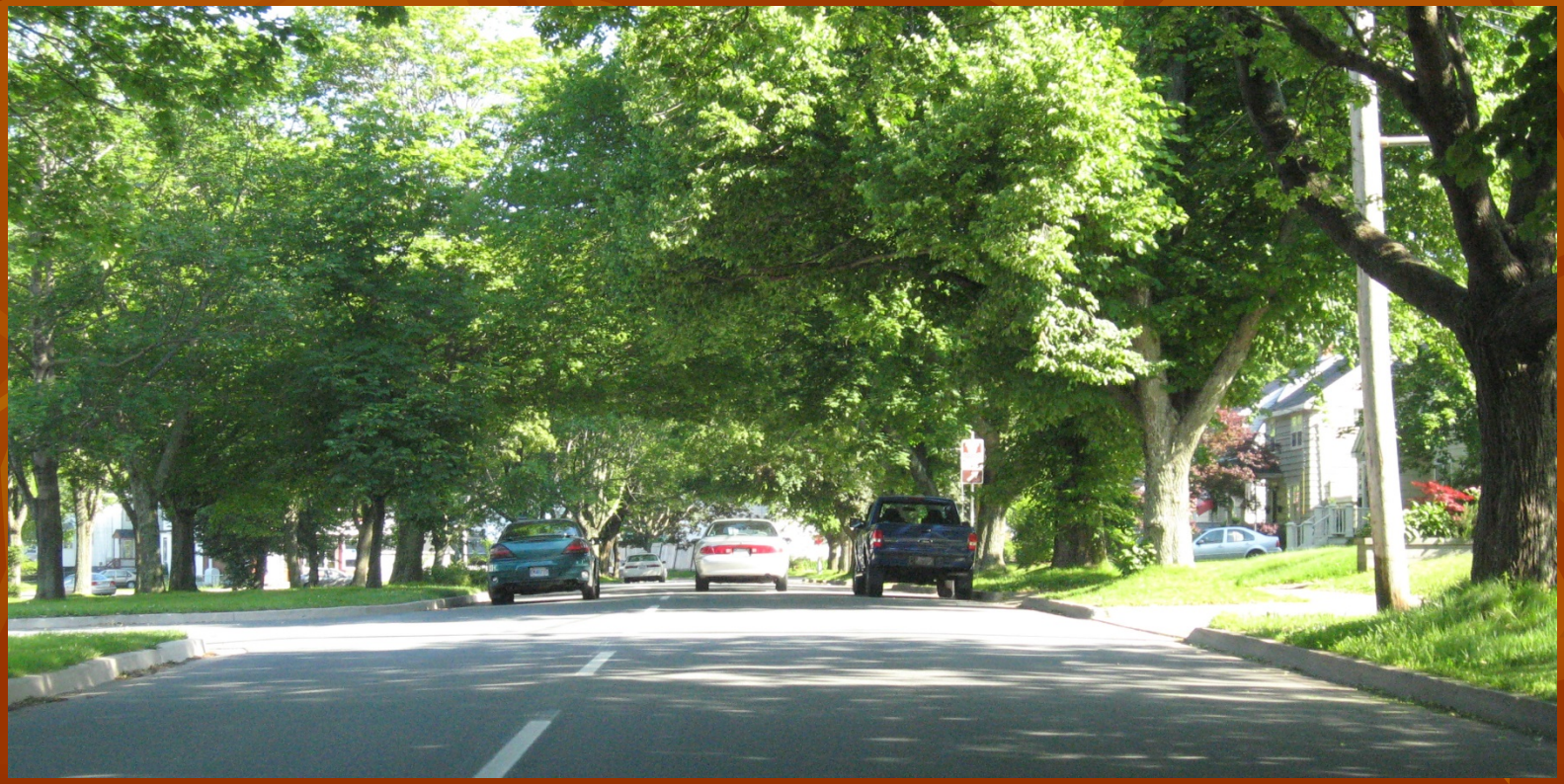
- Reduce evaporation of hydrocarbons
  - as vehicles sit fuel vaporizes from fuel tank and gas lines
  - reduction in emissions following shutdown and start up of a vehicle
- Asphalt retention through shading
  - as temperature rises the binder that holds the aggregates in asphalt evaporates and the pavement breaks down
- Parking lots thermal “hot-spots”
  - parking lots comprise large land areas in commercial and industrial areas, these large black surfaces absorb and retain large amounts of solar radiation
- Human comfort
  - the interior of a vehicle can reach 65C in a unshaded parking lot
- Act as storm water interrupters
  - most parking areas are comprised of large impervious surfaces that become large water catchments that drain into aquatic environments

Trees and how they extend the life of asphalt

- Asphalt is a combination of binder and aggregate.
- As temperatures rise the binder evaporates, asphalt gets harder, shrinks, and begins to crack.
- The life of asphalt is extended by treating it with a slurry sealant.
- The amount of slurry treatments needed can be diminished greatly by an increase in canopy cover.

Cost saving in asphalt retention

- Asphalt binders are products that are derived from oil and as the price of oil increases the price of asphalt increases.
- Over a 30 year life span, tree canopy cover can save up to $2,900 for a roadway section (roadway section 125ft by 35ft).



Trees and traffic calming

- Traffic calming is using structures to reduce vehicle speeds.
- How trees work in traffic calming:
  - Trees forewarn drivers of turns
  - Large trees give vertical presence, making streets seem narrower (trees help drivers gauge speeds)
  - A closed canopy gives the perception of driving in a tunnel (tree lined street can reduce speeds by as much as 15 mph)
  - Street trees work as physical barriers between pedestrian and vehicular traffic, defining the two traffic corridors

Why should we be slowing traffic

- 85% of pedestrians struck by a vehicles traveling at 40 mph (64 kph) become fatalities
- 45% of pedestrians struck by vehicles traveling at 30 mph (48 kph) become fatalities
- 5% of pedestrians struck by a vehicles traveling at 20 mph (32 kph) become fatalities
- There are 50% fewer collisions on traffic calmed streets

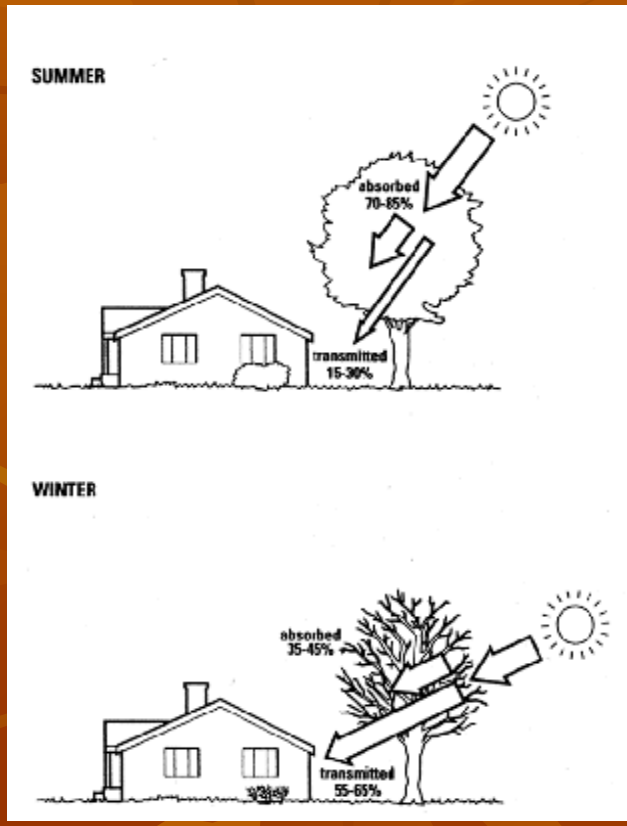
Trees increase property value

- Trees raise values on commercial, retail and residential properties
- Apartments and offices rent more quickly and have higher occupancy rates in treed areas
- Customers are willing to pay 10% more for certain product if the business are located on a tree lined street
- Property values increase 5%- 20% on treed properties (in Rochester, NY a study indicated that trees add more than 18% to the price of a home)
- Property values also increase with their proximity to green spaces or parks (in Surrey, BC a study found properties values increase as much as $11,000 for property near parks & green spaces)

Residential real estate values:
+ 3-7% with trees in yard
+ 5-20% proximity to natural open space
+ 9% when adjacent to street tree plantings
(K. Wolf, Ph.D.,)

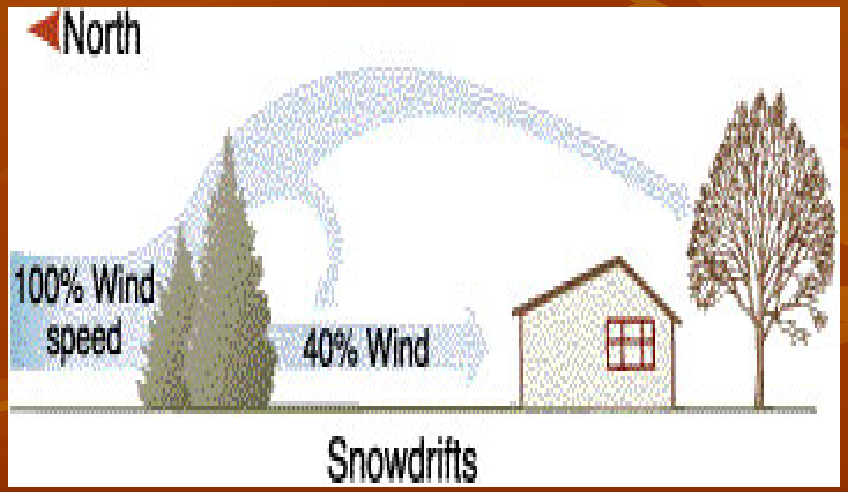
Trees and energy savings

- Appropriately placed trees save money in air conditioning cost and can also reduce heating cost
- Trees on the north side of buildings can reduce cold winter winds, reducing heating costs by 20%-30% (UCCEF,2001).
- Houston ,USA – $13,900,000 saving in winter heating cost alone
- The cooling effect of a young healthy tree equates to 10 room-size air conditioners running 20 hours a day



Trees used for visual, sound and wind barriers

- Trees are used as visual screens to hide undesirable sights, reduce glare of headlights, delineate boundaries for varying land uses and soften the visual impacts of buildings.
- Trees are used as sound buffers along roadways, commercial and industrial areas (a belt of trees can reduce highway noise by 6 - 10 decibels).
- Trees can be used to form windbreaks around homes, along roadways and open areas to shield against wind and snow.



Trees in riparian buffers and watershed areas

- Trees reduce the migration of pollutants
- Trees filter water
- Trees control storm water flow
- Trees retain water in soil table
- Trees stop erosion
- Trees shade shore line and stream edges which improves fish habitat
- Trees provide habitat and food for birds and small mammals

Trees; Recreation & Education

- As our population ages more areas of passive recreation are needed. Studies show that people are willing to pay $1.60 per visit to a tree covered park.
- Trees add needed shade to playground areas on hot days.
- For many children raised in urban areas, parks and urban forests are the only places where they get to experience nature.

Trees and crime prevention

- Studies out of the University of Illinois: have concluded that there is less crime in areas that have trees & greenery, comparde to identical areas that are barren of vegetation.
  - 48% less property crime and 56% fewer violent crimes

Trees location and size impact on benefits derived

- Where a tree is located impacts the amount and type of benefit:
- The closer a tree is to a pollution source, the greater the pollution absorbing benefits.
- 9 times more pollutants are absorbed by trees close to a pollution source than more distant trees. (One street tree provides more utility benefits then fifteen trees in the woods).
- A large tree has 425 times more benefit than a small tree in the same location.
- A large tree's net benefit is $4,400, a medium size tree $960, and a small tree $270.

Financial Benefits of Urban Street Trees

Northeast Community Tree Guide, USDA (Applicable to HRM)

Looks at the following to ascertain costs/benefits:

- energy saving
- increased property values
- stormwater mitigation
- air pollutants
- carbon sequestration

Annual Benefits	**Annual Costs**	**Benefit after cost over 40 years:**
small tree $26-$30	small tree $20	small tree $364
medium tree $69-$79	medium tree $27	medium tree $2,066
large tree $125-147	large tree $34	large tree $ 4,531
conifer tree $54-$56	conifer tree $23	conifer $1,322

Benefits of trees presently being quantified in HRM

- Filtering and cleaning of air
- Reduction of the heat island effect
- Storm water interruption
- Parking lot shading
- Retention of asphalt
- Traffic calming
- Energy saving
- Increase in property value
- Visual screens & sound buffers
- Recreation & education

Values that have been studied but no actual dollar amounts have been tied to

- Reduction in crime and physical violence
  - Apartment buildings with high levels of greenery have 52% fewer crimes than apartment buildings without trees
  - Chicago spent $10 million dollars in 2005 planting trees because of Kuo's & Sullivan's research in this area
- Faster patient recover rates when hospital windows has a view of trees
- Trees help create the feeling of relaxation and well-being
- Screening of uv light from skin
- Urban connection with nature
- The psychological link between people and trees through culture, socialization and co-adaptive history
- Access to wooded natural park areas is less dependent on income
- Aesthetics
- Wildlife habitat

Problems in the urban forest

- Planting and establishment
  - Competition for enough ground area to grow
  - Conflict with utilities and other needs
  - Development demands
  - Lack of nutrient replacement
  - Compaction of soils
  - Damage due to construction, vehicles and vandalism
- Urban environment
  - Urban pollutants
  - Pest & disease
  - Competition from invasive pests & non indigenous species

  Global warming (increased dramatic weather events)

  Financial and regulatory

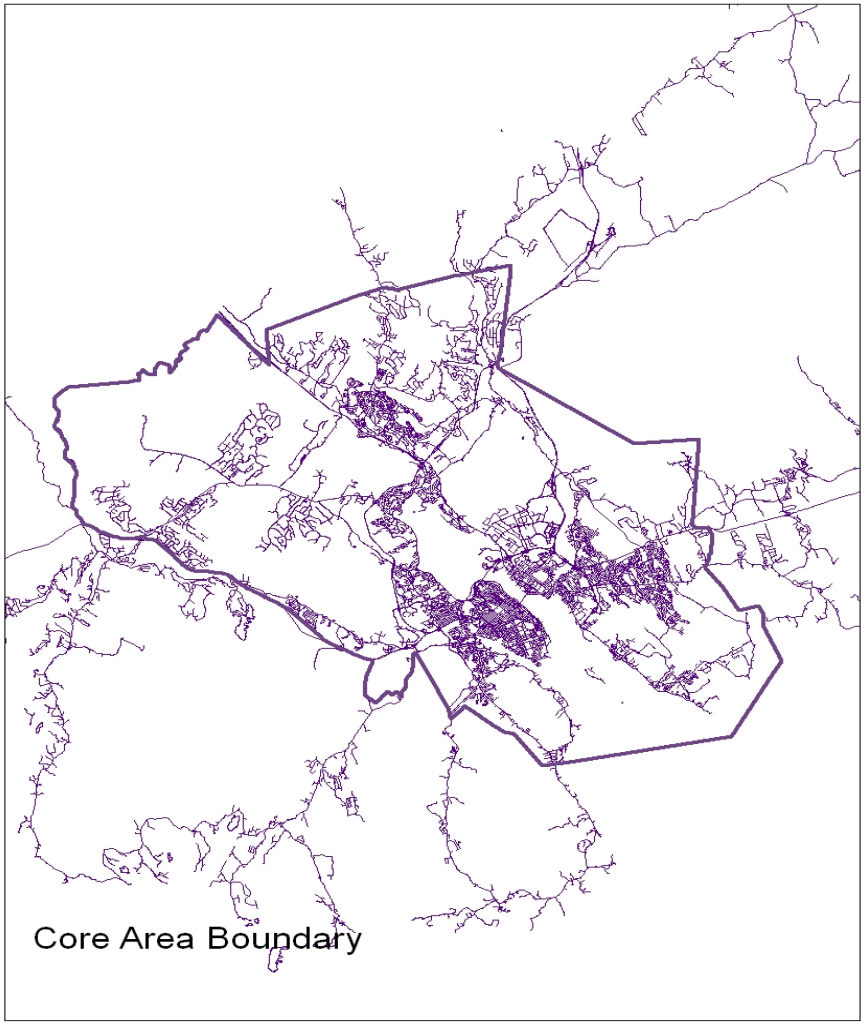
  Funding for urban forest needs
  - Lack of regulatory protection
  - Lack of education on the importance of trees
  - Lack of strategic long range plan, needs and outcomes
  - The need for internal policies around the importance of trees

Halifax Regional Municipality's Urban Forest

- HRM's Urban Forest refers to all trees, both public and private, which are found growing in HRM.
- HRM is responsible for, and manages, the trees on its properties.
- The internal responsibilities for this falls largely to TPW Operations.

HRM Prior to Data Collection

- We did not know much about UF profile other than patterns of planting and development, all anecdotal
- Municipalities
  - City of Dartmouth:
  - Town of Bedford:
  - City of Halifax:
  - Halifax County Municipality:
- Now we have some data and values


Core Area Boundary

In 2007-2008 HRM performed two studies to assess the urban forest

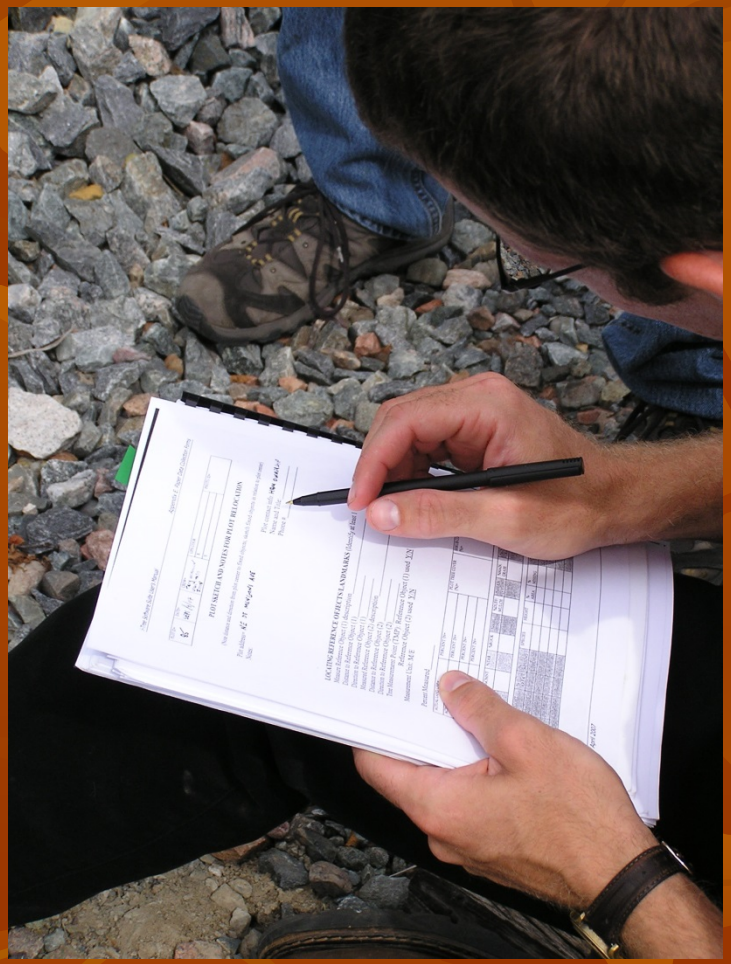
1. **UFORE (Urban Forest Effect Model)**
   - looked at overall canopy structure, pollutant removal, and carbon sequestration.

2. **STRATUM (Street Tree Management Tool for Urban Forest Managers)**
   - looked at street trees and trees in the road right-of-way, structure, pollutant removal, carbon sequestration, storm water control, aesthetic benefits

Both studies focused on the core service area (63,082 hectares) – x % of county?

HRM UFORE

- Looked at both public and private trees
  - 57,862,251 trees
  - 2,134,697 metric tones of carbon sequestered
  - 118,483 metric tones gross carbon sequestration per year
  - Replacement value of the trees $10.5 billion



UFORE Comparison

- Carbon Storage and Sequestration

City	Storage (tC) Total	SE	Annual sequestration Gross (tC / yr) Total	SE	Net (tC / yr) Total	SE	No. Trees (x 103) Total	SE	Tree cover (%) Total	SE	%
New York, NY	1,225,200	150,500	38,400	4,300	20,800	4,500	5,212	719	20.9		
Atlanta, GA	1,220,200	91,900	42,100	2,800	32,200	4,500	9,415	749	36.7		
Sacramento, CA	1,107,300	532,600	20,200	4,400	na	na	1,733	350	13.0		
Toronto, Ontario	**900,600**	**124,700**	**36,600**	**3,900**	**28,300**	**3,700**	**7,542**	**889**	**20.5**		
Chicago, IL	854,800	129,100	40,100	4,900	na	na	4,128	634	11.0		
Baltimore, MD	528,700	66,100	14,800	1,700	10,800	1,500	2,835	605	25.2		
Philadelphia, PA	481,000	48,400	14,600	1,500	10,700	1,300	2,113	211	15.7		
Washington, DC	474,000	51,000	14,600	1,500	11,700	1,300	1,928	224	28.6		
Calgary, Alberta	**403,700**	**99,400**	**19,400**	**2,600**	**17,000**	**2,300**	**11,888**	**2,777**	**7.2**		
Boston, MA	289,800	36,700	9,500	900	6,900	900	1,183	109	22.3		
Beijing, China	224,200	34,100	11,400	1,300	na	na	2,383	291	17.0		
San Francisco, CA	176,000	32,000	4,600	600	4,200	600	668	98	11.9		
Syracuse, NY	148,300	16,200	4,700	400	3,500	400	891	125	24.4		
Oakland, CA	145,800	4,900	na	na	na	na	1,588	51	21.0	0.2	
Oakville, Ontario	**133,000**	**12,900**	**6,000**	**400**	**4,300**	**400**	**1,908**	**192**	**29.1**		
Jersey City, NJ	19,300	2,600	800	90	600	100	136	22			
Halifax, N S.	2,363,076.5	130,603.9	126,042	445,094					61		

UFORE

Cities that have been analyzed using UFORE are:

Atlanta, GA; Baltimore, MD; Boston, MA; Brooklyn, NY; Calgary, Alberta; Hefei, China; Jersey City, NJ; Freehold, NJ; Moorestown, NJ; New York, NY; Ningbo, China; Philadelphia, PA; Syracuse, NY;

Toronto, Ontario, and Woodbridge, NJ.

Cities currently being analyzed are:

Baton Rouge, LA; Houston, TX; Morgantown, WV; Phoenix, AZ; San Juan, PR, and Santiago,Chile.

UFORE/ HRM land use data

Of the 63,082 hectares in the core service area:

- 39,033 hectares (both public and private) is canopied
  - Amounts to a 62% canopy
  - 24,542 (63%) of which is raw land yet to be developed in private ownership
- 6,479 hectares of HRM land is canopied
  - This equates into approximately 9,604,425 trees on HRM land
  - HRM controls 10% of the canopied lands within the core service area
  - Private ownership controls 90% of canopied lands

HRM STRATUM

- HRM STRATUM looked at both planted street trees and trees in the road right-of-way
  - 157,082 street trees in urban core
  - Another 553,012 trees in road right-of-way
  - Annual quantified benefit of trees in the road right-of-way, owned by HRM $43,440,501
- Benefit per ROW Tree = $61.18
- HRM Spending per ROW Tree = $1.27

Comparison on Urban Forest cost with other cities

- Chicago
- New York City
- Baltimore
- Washington DC
- Seattle
- Oakville
- Calgary
- Vancouver
- Halifax

Canopy by Land-Use

- Land-use types
- % of UF Canopy by Land-use
- What does this tell us?

Cases

- HRM land – we have control
  - Parks, Trails, Green Belts
  - ROWs
  - Institutional
  - Potable Water Sheds & Sanitary/Storm Systems (Halifax Water)
- Other public lands – some influence
  - Provincial and Federal parkland
  - Institutional Lands (e.g., DND)
- Private land – some controls needed?
  - Raw undeveloped
  - Developing (planning stage)
  - Developed
- More expenditure needed
- Street trees
- More investment in downtown
- Greater planting on vacant sites
- Resource lands – some cannot be canopied or retained
- Suburban commercial lands

Management Plan – Storm Water Mgmt Benefit

- Element/Value Column – storm water management
- Method – interruption, trans-evaporation, retention within canopy
- Generic Action / Positive Objective – maintain & increase canopy
- Indicators – lower peak flows, less time of peak flows
- Means available to impact HRM Land
- Means available to impact private land
- Impact-to-Effort Ratio that advises - +/-
- Effort-to-Success Probability that advises of our opportunity/risk to pursue

Legacy

- HRM's present Urban forest is made up of different types of tree planting approaches
- Previous municipal units utilized trees in varying ways
- Some based their canopy on street trees & parks
- Some green belt areas, connecting communities and buffering lakes
- Some restricted removals on private property

Conclusion

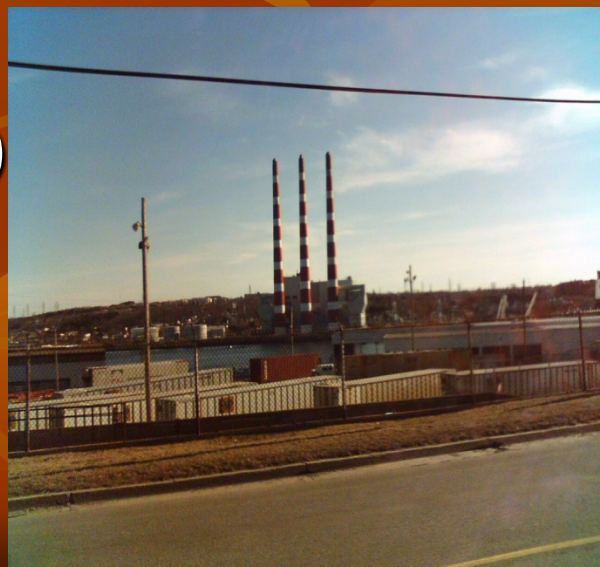
- Trees are true multi-taskers
- For every dollar spent HRM gets over seven dollars in return benefits
- The citizens of HRM have been left a great legacy in trees
- Managing and fostering an urban forest requires direction and support
- What legacy will we leave our children and grandchildren

Next Steps

- Public Consultation: Finding the public's values associated with urban forest (see PPP Management Plan column)
- Agreeing on Problems & Priorities
- Policy Options to Council
- Quantifying/Costing Options
- Street Tree Specimen Database

Some cities that have studied the annual value of air cleaning by trees:

- City of Seattle, USA- $4,894,000 (2006)
- City of Syracuse, USA - $851,500 (1994)
- City of Chicago, USA - $9,000,000 (1997)
- Washington, USA - $49,000,000 (2002)
- City of Frankston, Australia - $1,891,481 (2006)
- Oakville, Ontario - $1,261,000 (2006)



Economic value of storm water management by trees in some US cities

- Detroit, USA- $382,000,000 2002
- Washington D.C., USA- $4.7 Billion 2001
- Seattle, USA - $20,643,000 2006
- Modesto, USA - $616,139 1998
- Buffalo, USA - $41,605,332 2003
- Charleston, USA- $174,641 2006

References

- Heat Island http://www.epa.gov/heatisland/index.htmhttp
- Storm water: Center for Urban Forest Research - Pacific Southwest Research Station, USDA Forest Service ://www.urbanforestrysouth.org/resources/library/is-all-your-rain-going-down-the-drain/view
- Parking Lots: E.G. McPherson, J.R. Simpson, K.I. Scott. June 2004, **Publisher** USDA Forest Service, Davis, CA (US), Center for Urban Forest Researchhttp://www.urbanforestrysouth.org/resources/library/where-are-all-the-cool-parking-lots
- Asphalt retention :**Center for Urban Forest Research,** Pacific Southwest Research Station, USDA Forest Service, Davis, CA :http://www.fs.fed.us/psw/programs/cufr/products/cufr_673_WhyShadeStreets_10-06.pdf
- Sound Barrier: US Department Of Transportation http://www.fhwa.dot.gov/environment/keepdown.htm
- Riparian Buffers: Virginia Tech Cooperative Extension
  http://www.pubs.ext.vt.edu/420/420-153/420-153.html
  Carbon Sequestration: USDA Forest Service - Northern Region. Missoula, Montana
  http://www.treelink.org/docs/29_reasons.phtml
- Trees and crime: F.E.Kou, w.c.Sullivan. **ENVIRONMENT ANDCRIME IN THE INNER CITY. Does Vegetation Reduce Crime.**
  ENVIRONMENT AND BEHAVIOR, Vol. 33 No. 3, May 2001 343-367
  © 2001 Sage Publications, Inc.
- **http://www.landmarkwest.org/green/environment%20and%20crime.pdfe?**
  Wind: K. D. Coder , Professor, Silvics/Ecology Warnell School of Forest Resources, The University of Georgia
- **http://www.ottawaforests.ca/city_trees/values_e.htm**
  Crime :F. E. Kuo, University of Illinois at Urbana-Champaign
  http://www.lhhl.uiuc.edu/crime.htm
- **Large tree argument:** Center for Urban,Forest Research, Pacific Southwest Research Station, USDA Forest Service, Davis,
- California and the Southern Center for Urban Forestry Research & Information, Southern Research Station, USDA Forest Service, Athens, Georgia. 2004
  http://www.fs.fed.us/psw/programs/cufr/products/cufr_511_large_tree_argument.pdf
- David J. Nowak, Quantifying Ecosystem Services and Values of Urban Forests, USDA Forest Service, Northern Research Station, Syracuse, NY, USDA Forest Service, Northern Research Station
- **Kathleen Wolf, Ph.D., Social Science & Urban Greening**
  University of Washington, Seattle, USA.March 2009