An Initial Report on the Status of Street Trees in Springfield, Massachusetts




Tornado Damage to Springfield's Street Trees

June 2011

prepared for:

The City of Springfield, Massachusetts

prepared by:

Alex Sherman, City of Springfield
Rob Dill, City of Springfield
Edward Casey, City of Springfield

David V. Bloniarz, USDA Forest Service
Northern Research Station

Executive Summary

On June 1, 2011 a series of three tornadoes ripped through Western Massachusetts, and included the second strongest tornado ever recorded in Massachusetts, with wind speeds estimated at 136 to 165 mph, according to the National Weather Service. The most severe tornado was the EF-3, on the Enhanced Fujita Damage Classification Scale, that carved a half-mile-wide path for 39 miles from Westfield to Charlton, killing three people and injuring 200. The main path of the storm followed a track through the city of Springfield, MA impacting many of its neighborhoods including the South End, Six Corners, East Forest Park and Sixteen Acres neighborhoods.

The tornado resulted in major damage to city infrastructure including many buildings and dwellings, power lines, and public shade trees. In the neighborhoods of Springfield affected by the storms, damage to the street trees was extensive, destroying or severely damaging many of the public trees growing in these areas. A team of US Forest Service and City of Springfield personnel conducted a preliminary review of the streets in these neighborhoods, and an initial summary of the storm impacts was developed. The purpose of this report is to detail the initial assessment of the potential ecological and economic losses to the city of Springfield due to the damage of the street tree resource.

The following table outlines background information on the street trees in Springfield, and includes a summary of preliminary findings related to damage resulting from tornados:

Springfield's Street Trees Quick Facts	
Total Street Trees	27,657
Most Common Genus (% of Total)	Maple (45.7%)
Three Most Common Species (% of Total)	Norway Maple (22.4%), Sugar Maple (15.1%), Northern Red Oak (6.4%)
Total Annual Benefits of Street Trees	$2,611,425
Total Street Tree Replacement Value	$66,425,234
Number of Miles of Roadway in Impact Zone	87 miles
Number of Street Trees in Impact Zone	3,830 (14% of total street trees)
Percent of Street Trees in City Impacted	16.1%
Approximate Number of Street Trees Lost	1,340

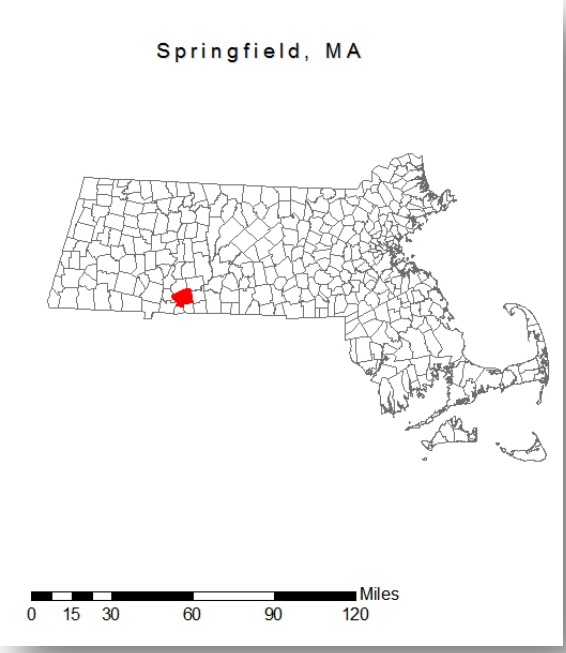
Analysis Methods

This report was generated using ESRI's ArcView GIS for geospatial analysis and i-Tree STREETS for the forest structure, ecological, and benefit analysis of the trees. The i-Tree software suite was developed by the USDA Forest Service, and other partners, as a tool for urban tree managers to quantify the structure, function and value of a communities' tree resource. It is based on state-of-the-art research tools and its models have been used across the world to establish the value of environmental components of urban landscapes.

The existing street tree inventory was loaded into ArcGIS format and clipped by the impact zone polygon layer received from the city GIS department. The i-Tree STREETS software was used to analyze the portion of the street trees located within the tornado affected zone as defined by Springfield Department of Public Works (DPW). The impact zone polygon represents a wide swath that runs west to east across the city. Areas closer to the main track of the storm experienced severe damage with all street trees destroyed in some cases. As you move north or south of the main storm event the damage is less severe including broken branches. A preliminary assessment made by the authors determined approximately 35% of trees within the impact zone were damaged or destroyed as a result of the storm. This assessment was used to approximate the actual losses to the city of Springfield.

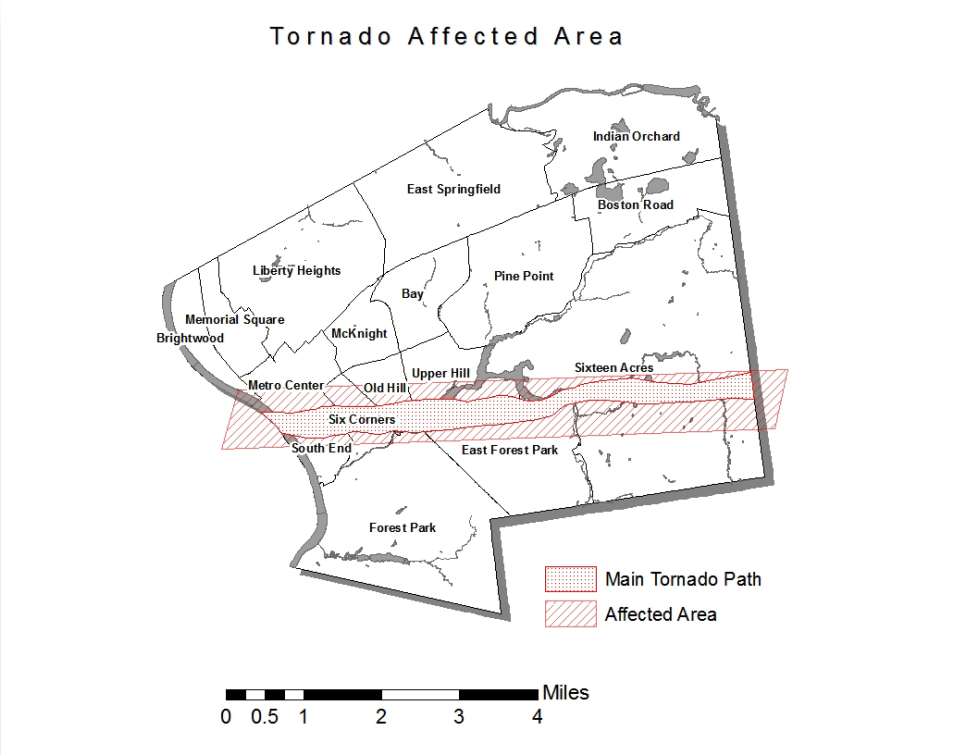
Location

Springfield, MA is located at 42°6' 55''N and 72°32'23'W (42.115454, -72.539978) in the western part of the state and with the Connecticut River acting as the western border. It is the state's third largest city with a total population of 153,060 according to the 2010 US Census. The city occupies approximately 32 square miles in which 1.2 square miles are water.



Tornado Impact Areas

In Springfield, the main path of the storm followed a track through a number of neighborhoods that ranged from urban core to suburbanized landscapes. Included in the path were nine city parks, the Springfield College campus, a city-owned summer camp, and large areas of protected conservation lands.



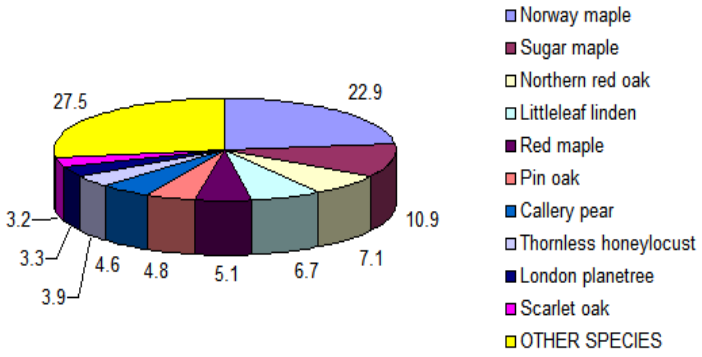
In the South End, Six Corners, East Forest Park and Sixteen Acres neighborhoods, a sizeable number of street trees were destroyed, severely damaged or will have long-term implications associated with them, including susceptibility to insects, decay and disease

Analysis of Street Tree Structure in Impact Zone

Species Composition

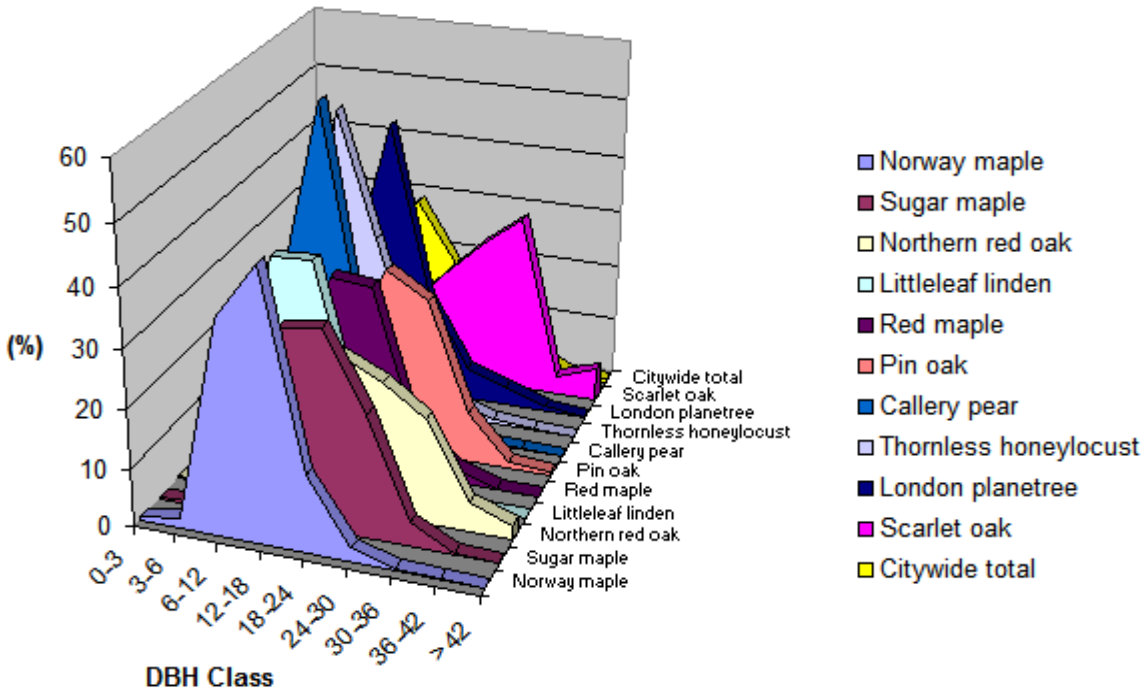
The genus Acer (Maple) is the most abundant within the impact zone. Norway maple comprises almost 23 percent and Sugar maple comprises almost 11 percent of the street trees in the impact zone. It has been shown 6 years after a storm event resulting in tree crown damage, 26.8% of damaged maple trees required removal (Luley and Bond 2006). Northern red oak and Littleleaf linden also comprise significant percentages of the street trees in the impact zone with approximately 7% each.

Species	Percent
Norway maple	22.9
Sugar maple	10.9
Northern red oak	7.1
Littleleaf linden	6.7
Red maple	5.1
Pin oak	4.8
Callery pear	4.6
Thornless honeylocust	3.9
London planetree	3.3
Scarlet oak	3.2
OTHER SPECIES	27.5
Total	100



Relative Age Distribution

The relative age distribution is determined by Diameter at Breast Height (DBH) of the tree measured 4.5 feet from the ground. A majority of the street trees within the impact zone are between 12 and 18 inches DBH, with some species occurring at mostly smaller diameters and a few species accounting for very large trees. Trees within the 12 to 18 inch DBH size classes comprise a majority of the over-story of Springfield's urban forest canopy. Trees within these size classes and larger have sustained a majority of the damage from the high winds of the storm. Scarlet oak, Northern red oak, and the maple Genus occupy a majority of the trees in the larger size classes and it is expected that these species have incurred the most damage.



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Norway maple	0.57	1.71	36.33	45.90	13.10	2.28	0.11	0.00	0.00
Sugar maple	0.24	0.72	6.71	32.85	34.05	21.10	4.08	0.24	0.00
Northern red oak	0.37	0.37	8.42	15.75	26.37	23.08	17.95	5.13	2.56
Littleleaf linden	1.56	8.98	37.50	37.89	12.11	1.56	0.39	0.00	0.00
Red maple	2.55	5.61	17.35	32.14	31.63	8.16	2.55	0.00	0.00
Pin oak	1.09	4.89	8.15	16.85	31.52	27.17	8.70	1.09	0.54
Callery pear	4.52	23.73	55.37	16.38	0.00	0.00	0.00	0.00	0.00
Thornless honeylocust	0.00	6.04	51.68	30.20	8.72	2.68	0.67	0.00	0.00
London planetree	0.79	3.17	21.43	47.62	17.46	5.56	3.17	0.79	0.00
Scarlet oak	0.00	1.65	1.65	11.57	19.01	25.62	31.40	3.31	5.79
Areawide total	7.42	6.76	23.11	28.77	18.04	9.84	4.44	0.97	0.65

Relative Performance Index

The RPI relates the overall condition of each species in comparison to all the others; the information is presented in table form. Any value higher than 1 indicates species that have proportionately better condition ratings. Likewise, index values lower than 1 are species with below-average condition ratings when compared with other inventoried street trees. The RPI of each species provides an indication of its suitability to local growing conditions, as well as its performance. Species with more trees in good or better condition are likely to provide greater benefits at less cost than species with more trees in fair or poor condition.

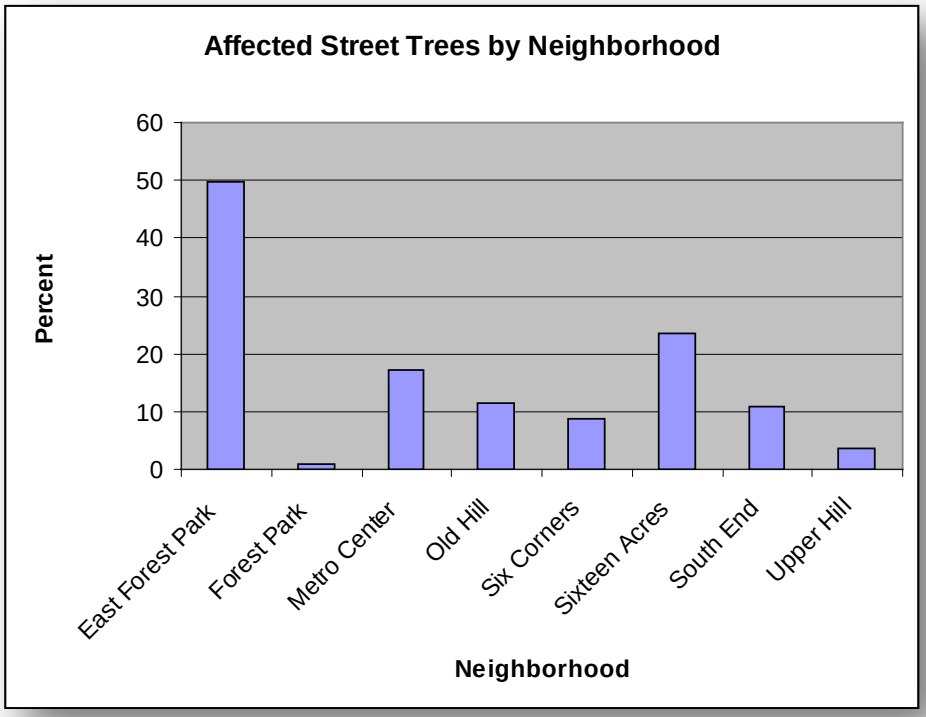
Relative Performance Index for Public Trees

6/23/2011

Species	Dead or Dying	Poor	Fair	Good	Excellent	RPI	# of Standard Trees Error	% of Public
Norway maple	0.00	1.31	43.05	5.69	49.94	1.00	878 (N/A)	22.92
Sugar maple	0.00	2.52	43.53	4.44	49.52	0.99	417 (N/A)	10.89
Northern red oak	0.18	2.01	45.05	3.11	49.63	0.98	273 (N/A)	7.13
Littleleaf linden	0.00	1.17	42.58	6.45	49.80	1.00	256 (N/A)	6.68
Red maple	0.00	3.06	43.88	3.06	50.00	0.98	196 (N/A)	5.12
Pin oak	0.00	0.82	41.85	7.34	50.00	1.00	184 (N/A)	4.80
Callery pear	0.00	1.41	46.89	1.69	50.00	0.98	177 (N/A)	4.62
Thornless honeylocust	0.00	0.00	46.98	3.02	50.00	0.99	149 (N/A)	3.89
London planetree	0.00	0.00	23.02	26.98	50.00	1.07	126 (N/A)	3.29
Scarlet oak	0.00	0.00	48.76	1.24	50.00	0.99	121 (N/A)	3.16
Apple	0.45	3.18	40.91	5.45	50.00	0.99	110 (N/A)	2.87

Distribution of Impact Zone by Neighborhood

The East Forest Park neighborhood contains almost 50% of street trees within the impact zone. Sixteen acres contains near 25% and Metro Center accounts for 17% of the total.



It is important to note that although some neighborhoods contain a large portion of the affected trees, smaller neighborhoods, such as the South End, experienced severe tree damage and loss. The percentage of street trees affected by neighborhood totals is presented below.

Neighborhood	Number of Affected Trees	Percent of Neighborhood Total
East Forest Park	1581	44%
Forest Park	25	<1%
Metro Center	505	52%
Old Hill	333	51%
Six Corners	233	74%
Sixteen Acres	800	20.5%
South End	250	61%
Upper Hill	103	11.4%
Total	3830	100%

The Six Corners neighborhood contains the most affected trees with 74% of the neighborhood street trees located within the impact zone. 61% of the street trees in the South End are within the storm impact zone. Metro center and Old Hill also have more than 50% of their street trees located within the storm zone. These neighborhoods are likely the most negatively impacted by damage to the street trees.

Quantifiable Loss Analysis

The multiple benefits of urban trees are widely accepted, yet they can be difficult to quantify. Energy savings, storm water run-off reduction, and carbon balance are more easily quantified than aesthetics for example. The dollar values calculated are approximations based on scientific research published by numerous experts. Not every street tree in the impact zone has been uprooted or damaged beyond recovery. An on the ground field analysis of the streets in the impact zone by a inspection team of Forest Service and City of Springfield Forestry staff estimates that 35% of all street trees in the impact zone have suffered catastrophic damage and require removal or were downed by the tornados. The numbers expressed below reflect the benefits of all trees located in the impact zone and the value associated with the estimated 35% of trees lost.

Annual Benefits of Impact Zone Street Trees			
Benefit	**Quantity**	**Impact Zone Value**	**Loss Value**
Energy Saved			
Electricity (MWh)	360.6	$18,393	$4,598
Natural Gas (therms)	129,018.6	$85,439	$29,903
Total ($)		**$103,832**	**$34,501**
Carbon Dioxide			
CO_2 Sequestered (lbs)	946,377	$3,123	$1,093
CO_2 Released (lbs)	-244,714	-$808	-$283
CO_2 Avoided (lbs)	1,086,259	$3,585	$1,255
Total (lbs, $)	**1,787,922**	**$5,900**	**$2,065**
Air Quality			
Avoided pollutants* (lbs)	4954	$21,451	$7,508
Deposited pollutants** (lbs)	4264	$22,958	$8,035
BVOC emitted (lbs, $)	-1,140	-$2,634	-$922
Total (lbs, $)	**8,078**	**$41,775**	**$14,621**
Storm Water			
Rainfall intercepted (gal)	6,983,576	**$55,872**	**$19,555**
Aesthetic/Other			
Added Property Value		**$140,569**	**$49,199**
TOTAL VALUE		**$347,948**	**$121,782**

*NO 2 , SO 2 , VOC, PM10 **O 3 , NO 2 , PM10, SO 2

The approximated loss of 35% of the street trees in the impact zone will lead to an annual loss of $121,782 to the City of Springfield and the residents of the affected neighborhoods.

Immediate impacts include the reduction of rainwater interception by 2,444,252 gallons; reduced storage of 3,441,539 pounds of carbon; approximately 331,232 pounds of sequestered CO2 has been lost due to the removal of 1,340 street trees growing in the impact zone. An i-Tree Canopy analysis is presently being undertaken, which will expand these loss calculations over the impact zone, including all public and private lands. Preliminary estimates show that over 60 million gallons in stormwater interception has been reduced due to the impact to the tree canopy, and over $3.4 million in quantifiable annual benefits have been reduced due to the impact on all trees from the tornados.

Replacement Values

i-Tree Streets calculates replacement values for trees using the Council of Tree and Landscape Appraisers Guide, 9th edition. The replacement value is the cost of replacing trees in their "current condition" (i-Tree 2011). Based on loss of over 35% of the street trees in the impact zone, it is estimated that the replacement value for these trees is over $8 million.

Conclusion

The Tornado has left a mark on the City of Springfield that will take many years to erase. This is no more evident than with the loss of the tree resource within the impact zone. The landscape will never be the same as before the storm and it will take many years to recover the canopy cover lost in some areas. While this loss is a tragedy, with reforestation efforts and proper management, the urban forest in these areas can be healthier than it ever has been. There is a great opportunity to apply the latest knowledge and professional practices of urban forestry to ensure healthy and vigorous trees will once again line the streets of the neighborhoods affected. This report can serve as a reference to outline the values and benefits of street trees and allow decision makers to make informed choices when planning the recovery of the neighborhoods affected by the tornados.

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