Assessing Storm Damage in Urbanized Landscapes: Preparation, Response & Recovery

David Bloniarz, USDA Forest Service

Northern RESEARCH STATION USDA Forest Service

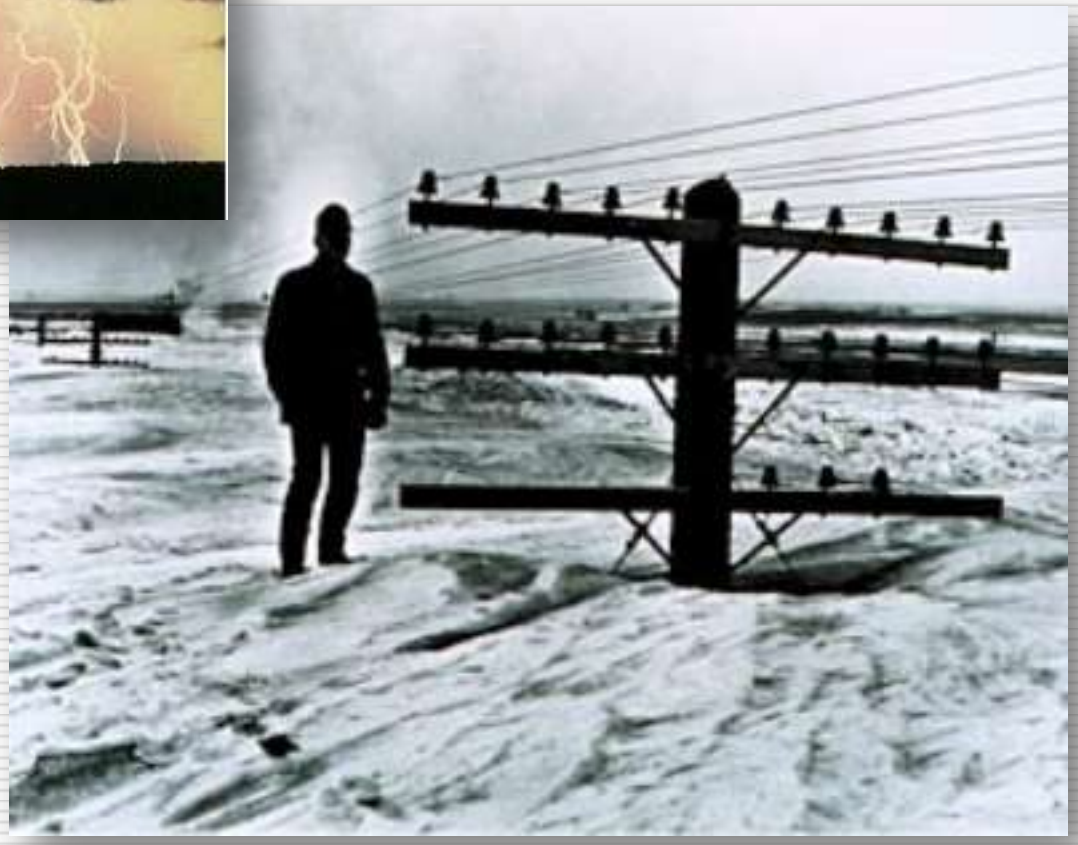
www.unri.org/research-documents

Northern
RESEARCH STATION
USDA Forest Service

Why Prepare?

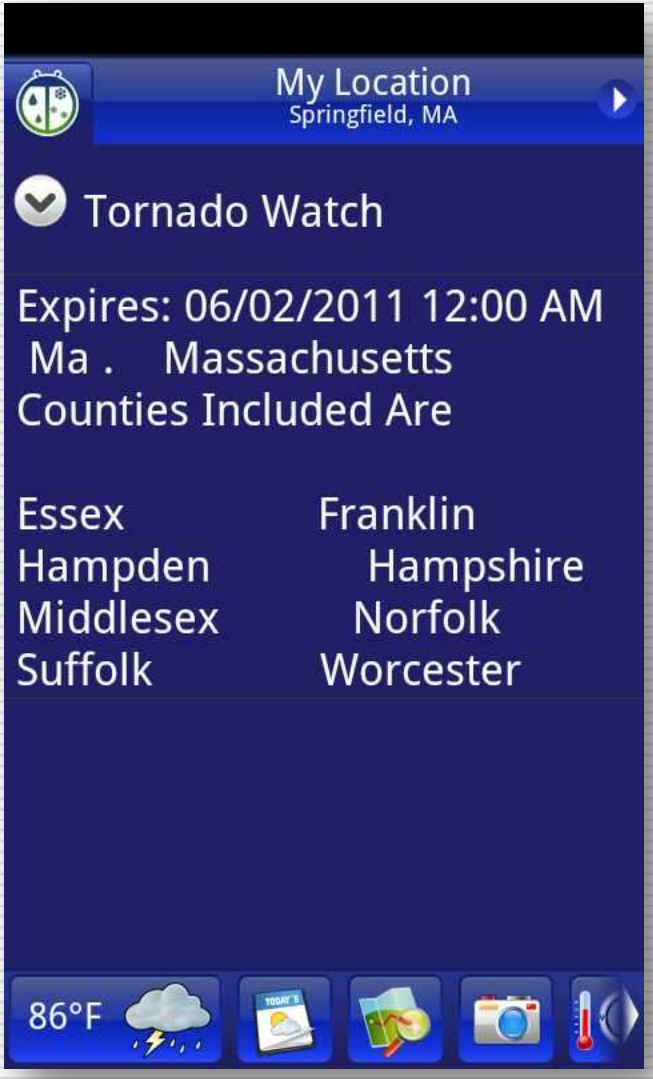
Tornados

Thunderstorms & Wind

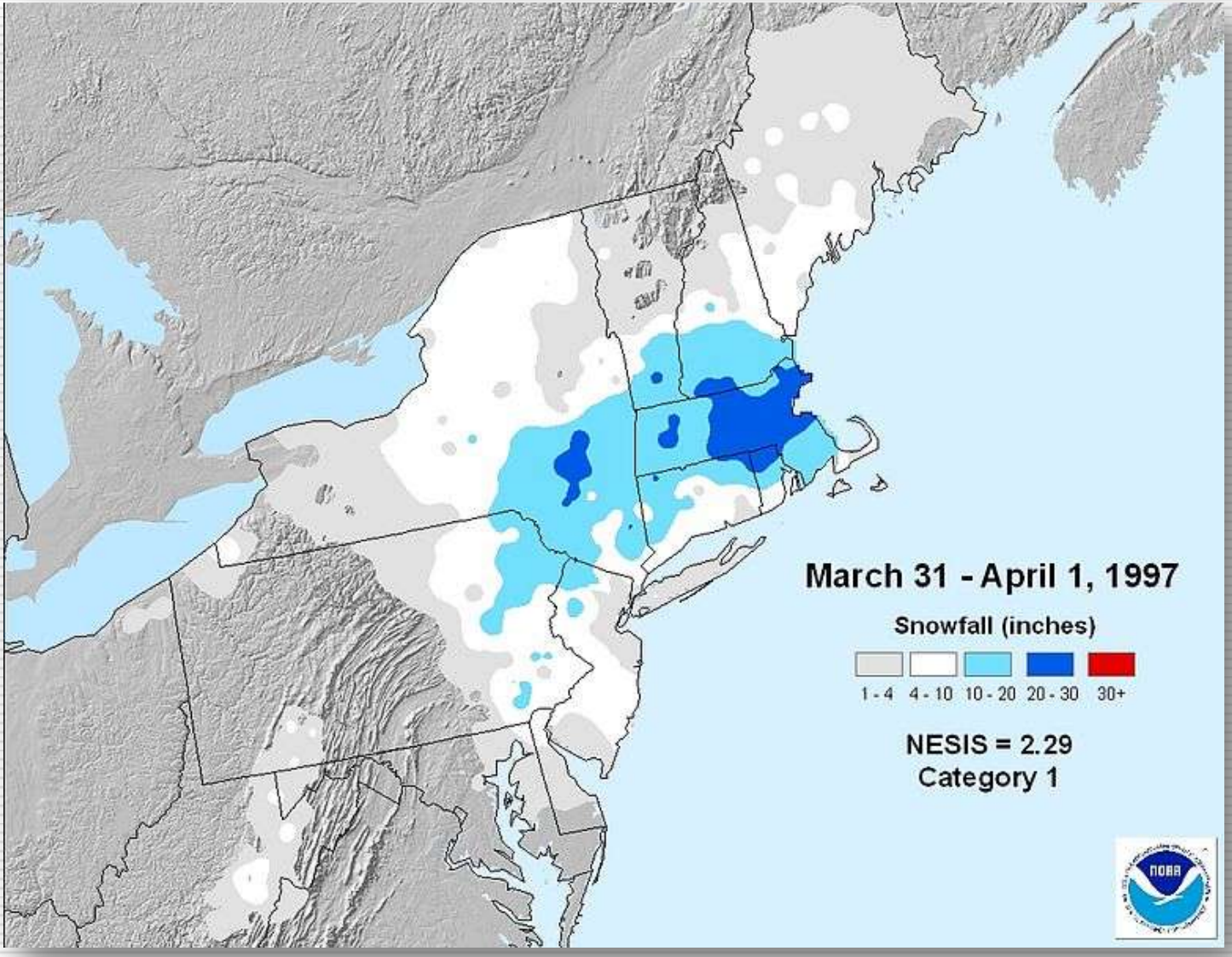


Snow

Any Time, Any Place….

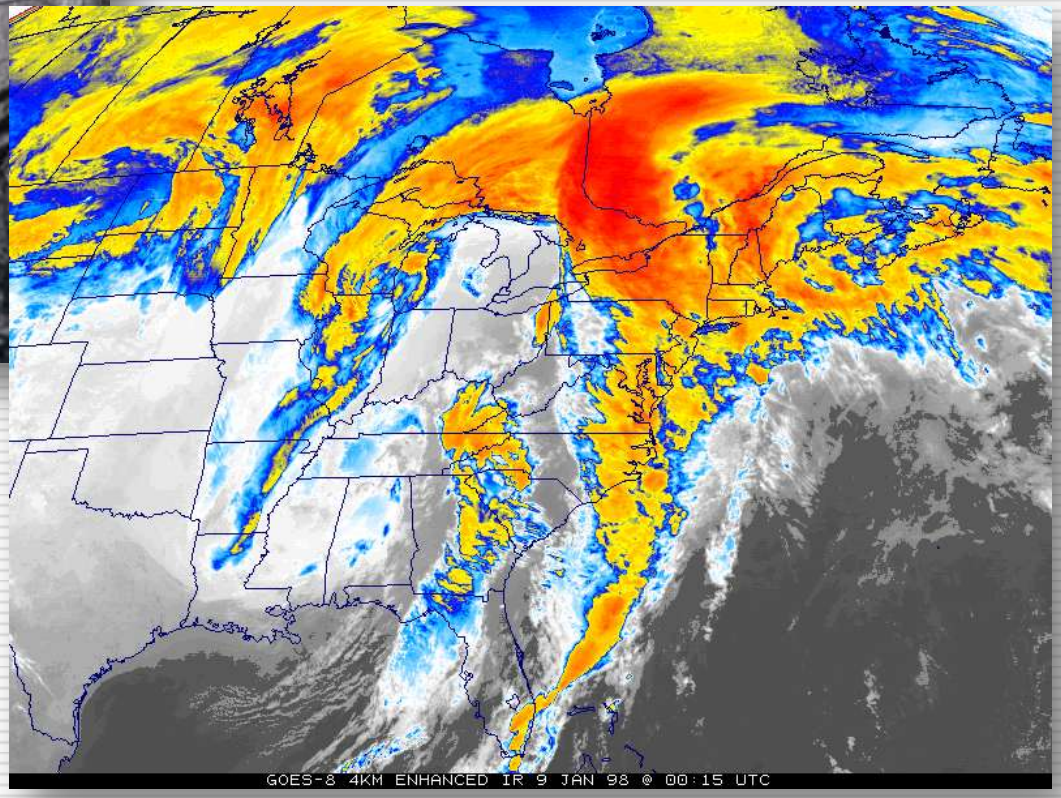


1997 April Fool's Day Blizzard



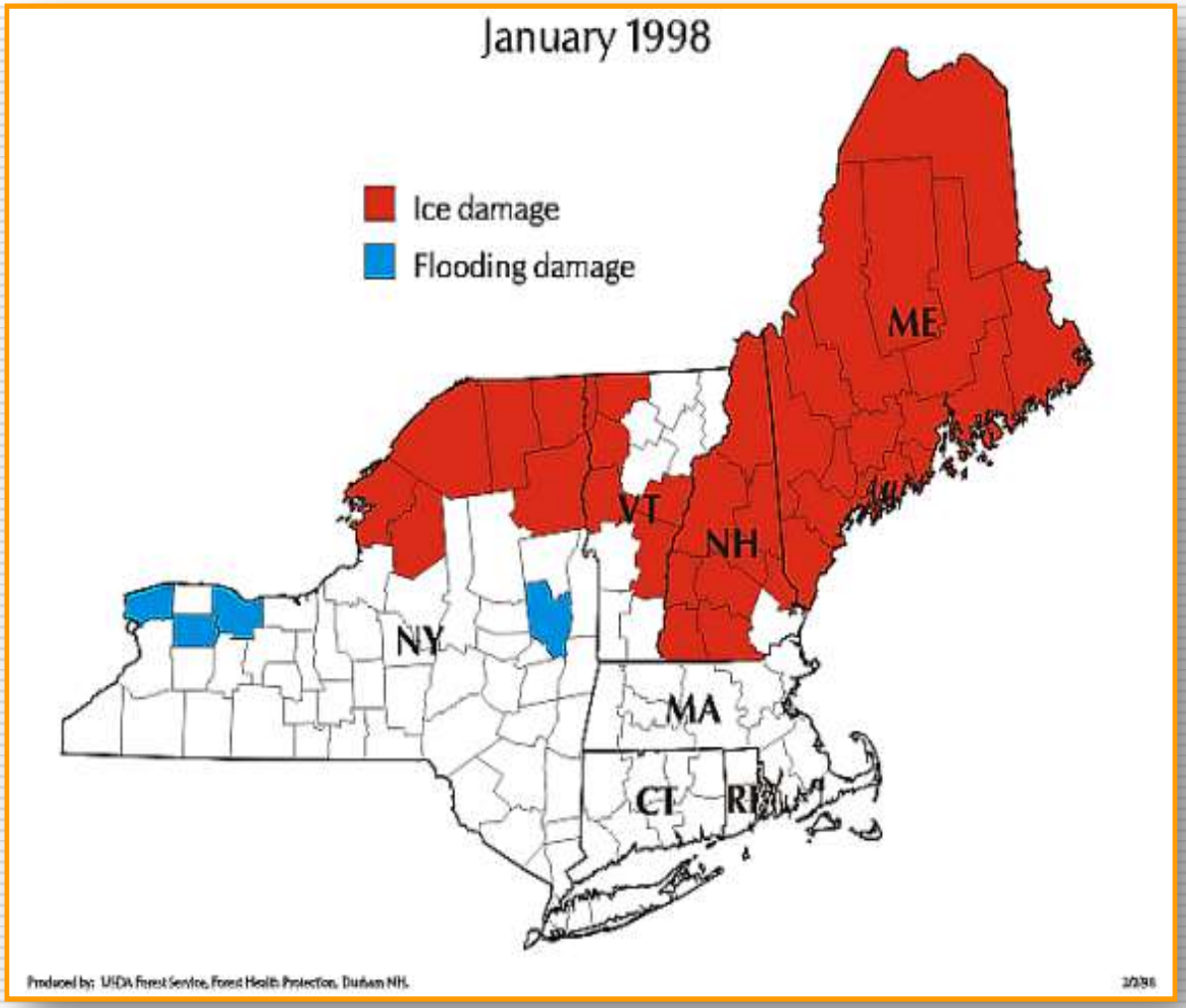
1997 April Fool's Day Blizzard

- 700,000 customers Lost Electricity
- Nearly 13% of New England lost power
- Boston's greatest April 24-hr snowfall



1998 Northeast Ice Storm Storm

FEMA Disaster Aid



Tree Damage

Transmission tower outside Montreal

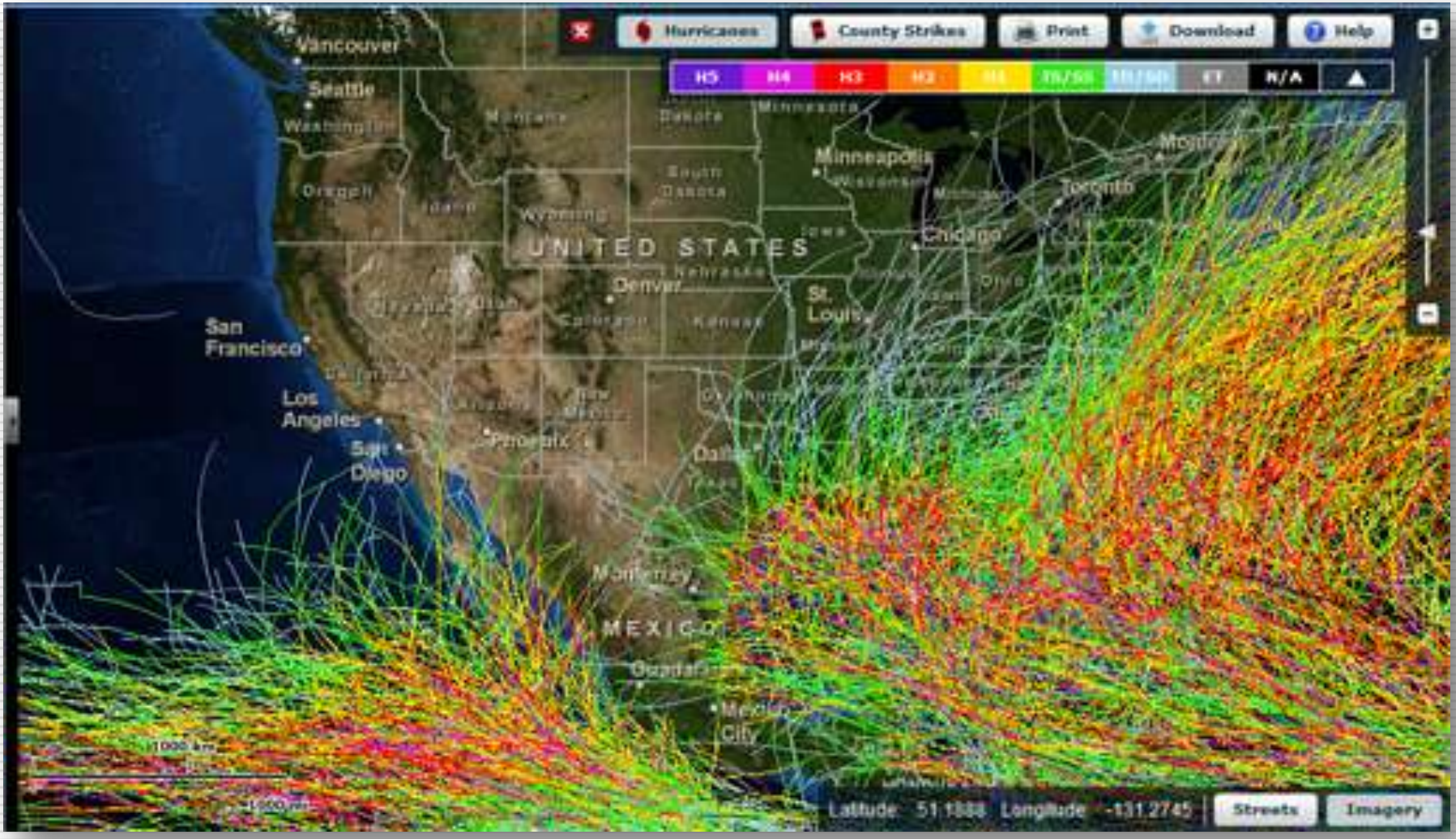
Urban Core Impacts

Downtown Montréal

Landscape Scale Damage

Central Vermont - January 1998

Historical Tracks of US Hurricanes



Isabel 2003: "A Storm of Trees"

COPING WITH ISABEL: WHAT YOU NEED TO KNOW

13 PAGES OF SPECIAL COVERAGE INSIDE ■ TIPS, CLOSINGS AND INFORMATION ON HOW AND WHERE TO GET HELP/PAGES A20-A21

SATURDAY

The Virginian-Pilot

■ 1.8 million Dominion customers lost power
■ Northern end of Hatteras Village decimated
■ At least 17 in four states reported dead

SWEPT AWAY

THE OUTAGES

"Catastrophic" damage done to power grid, officials say

AFTERMATH Q&A

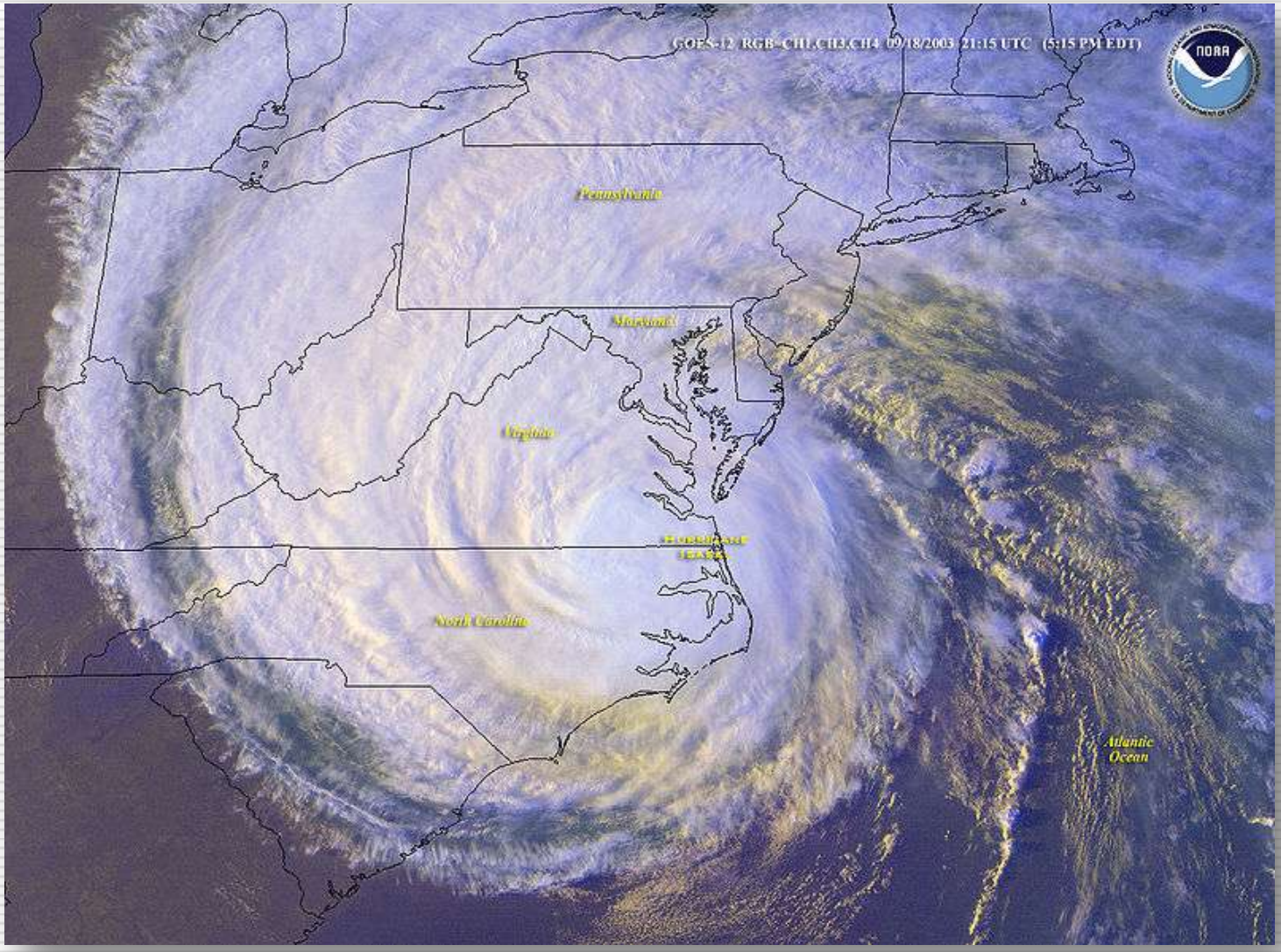
From downed lines to water, problems Isabel left behind

THE OUTER BANKS

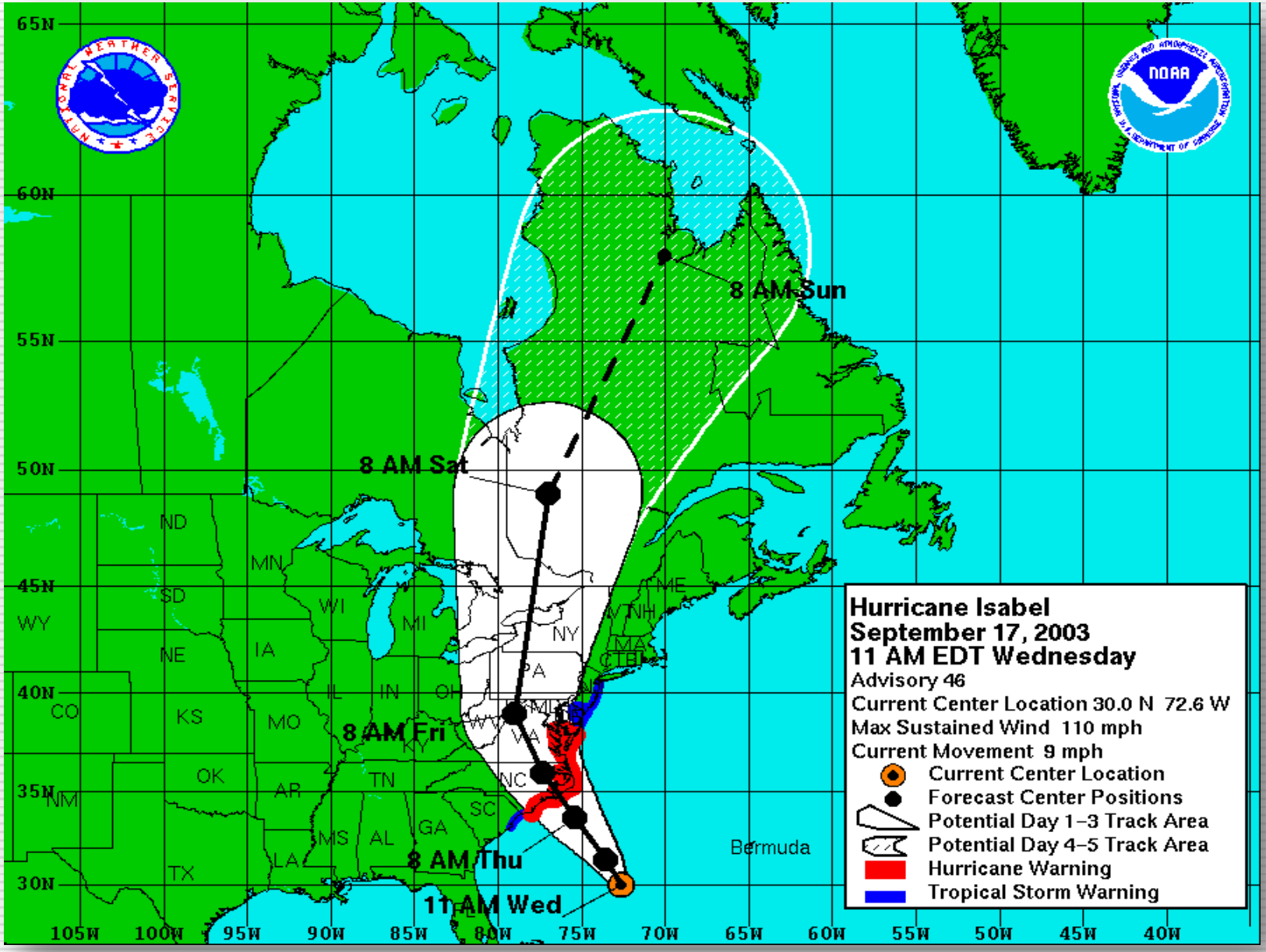
Hatteras Village isolated after hurricane cuts island in half

ISABEL PUNCHED THROUGH HATTERAS ISLAND

Isabel 2003: "A Storm of Trees"



Isabel 2003: "A Storm of Trees"



Isabel 2003: "A Storm of Trees"

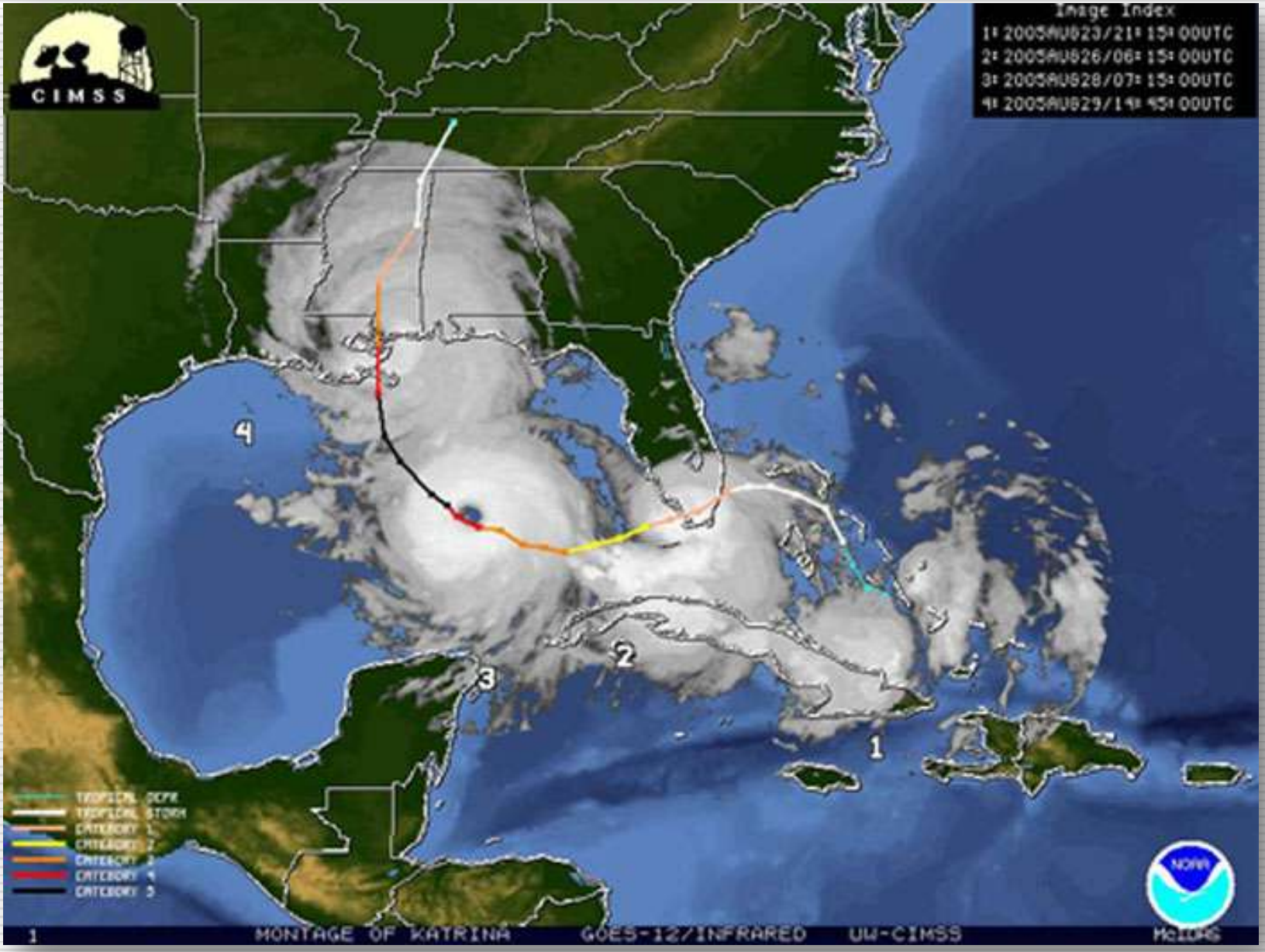
- Affected Maryland and Washington, DC
- $945 million (2003 USD, ($1.13 billion 2011 USD)
- Highest Sustained Winds 60 MpH
- Over 2 million households/businesses lost power

Isabel 2003: "A Storm of Trees"

Isabel "wreaked havoc on the forest of urban and suburban trees… Many of them are so big that, when blown over by tropical storm-force winds, they're likely to find a power line that was once thought safely distant."

- Pat Michaels
  Virginia State Climatologist

Katrina: Beyond the Trees

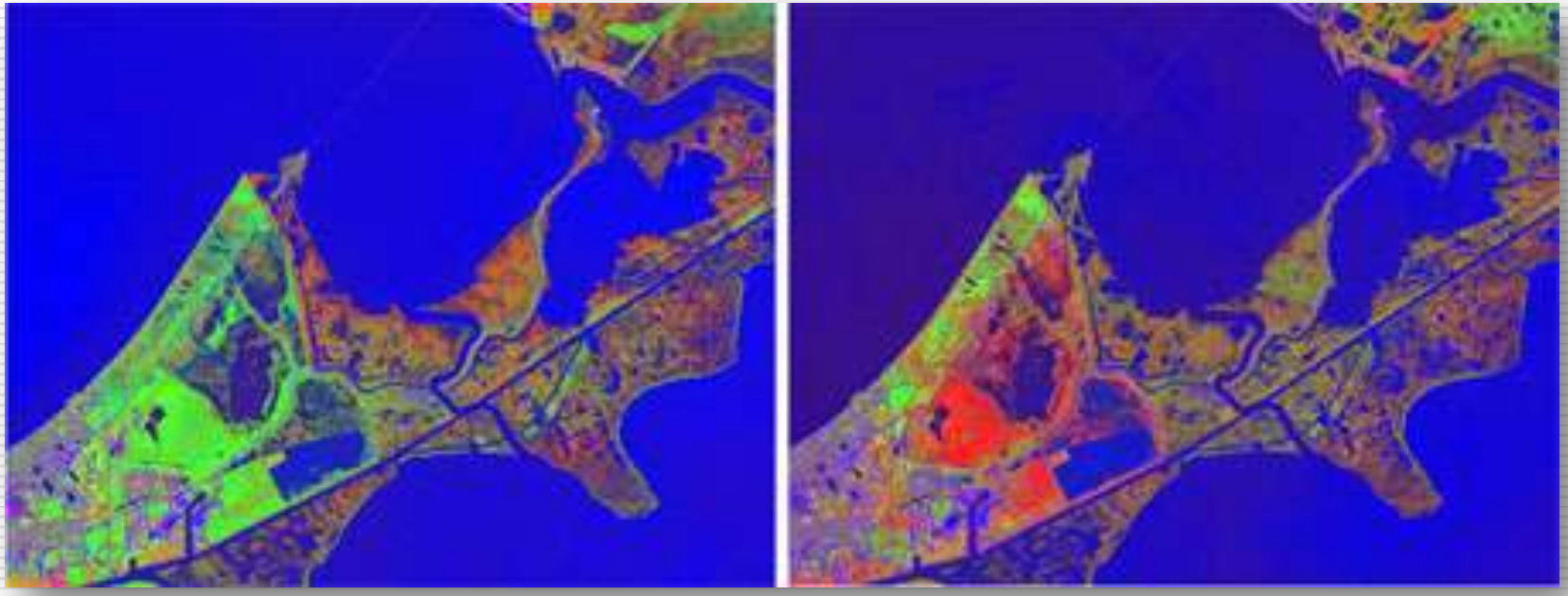


Katrina: Beyond the Trees

- $81 Billion in damage
- 1,836 fatalities
- 80% New Orleans submerged
- 3 million without elecricity
- 90,00 sq miles declared disater

Katrina: Beyond the Trees

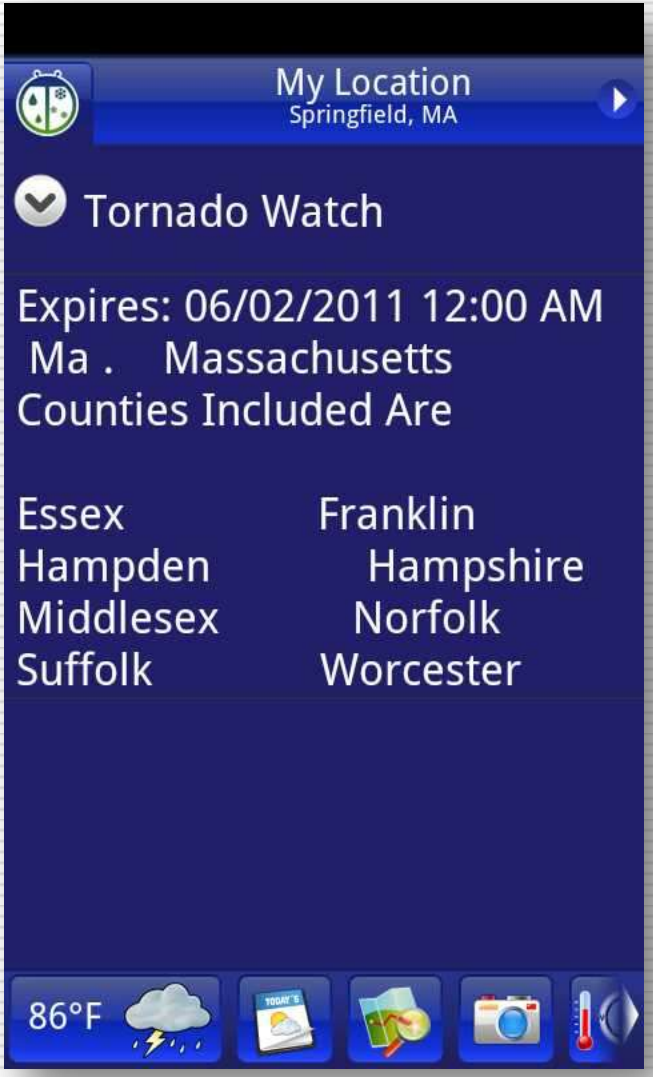
Katrina: Tree Loss



http://www.nasa.gov/mission_pages/hurricanes/archives/2007/katrina_carbon.html

- 5 million acres affected
- 320 million trees lost

Western/Central Massachusetts
June 1, 2011 Tornado



Western/Central Massachusetts June 1, 2011 Tornado

4:30 p.m.
Possible tornado touchdown in Shaker Road area.

6:07 p.m.
Electric company reported to police a tornado on the ground in southwest portion of Westfield.

4:32 p.m.
Amateur radio operator reported tornado on the ground one-half mile from Main Street. Widespread damage.

6:20 p.m.
State Police report tornado in north Springfield area.

5:22 p.m.
State Police report tornado on the ground in Sturbridge on Interstate 84 exit. Cars overturned.

7:25 p.m.
Amateur radio report of a tornado touchdown in Sturbridge at Route 49A.

NOTE: Preliminary information from NOAA as of 10:30 p.m. yesterday.

SOURCES: National Oceanic and Atmospheric Administration ; ESRI; TeleAtlas

PATRICK GARVIN/GLOBE STAFF

Western/Central Massachusetts June 1, 2011 Tornado

Western/Central Massachusetts
June 1, 2011 Tornado

Western/Central Massachusetts
June 1, 2011 Tornado

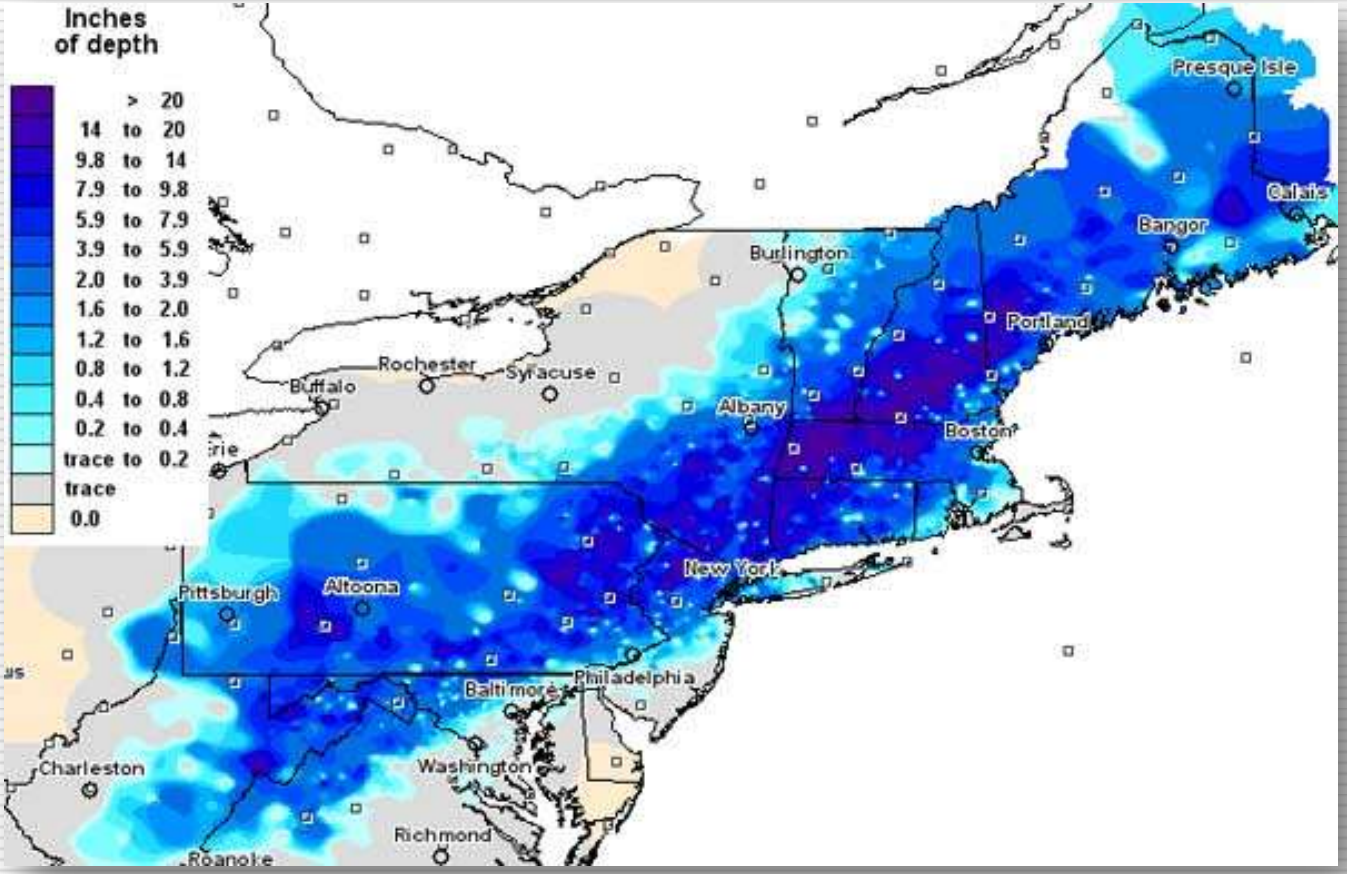
Tornado
June 1, 2011
Springfield MA.

‘Snowtober Surprise – October 2011

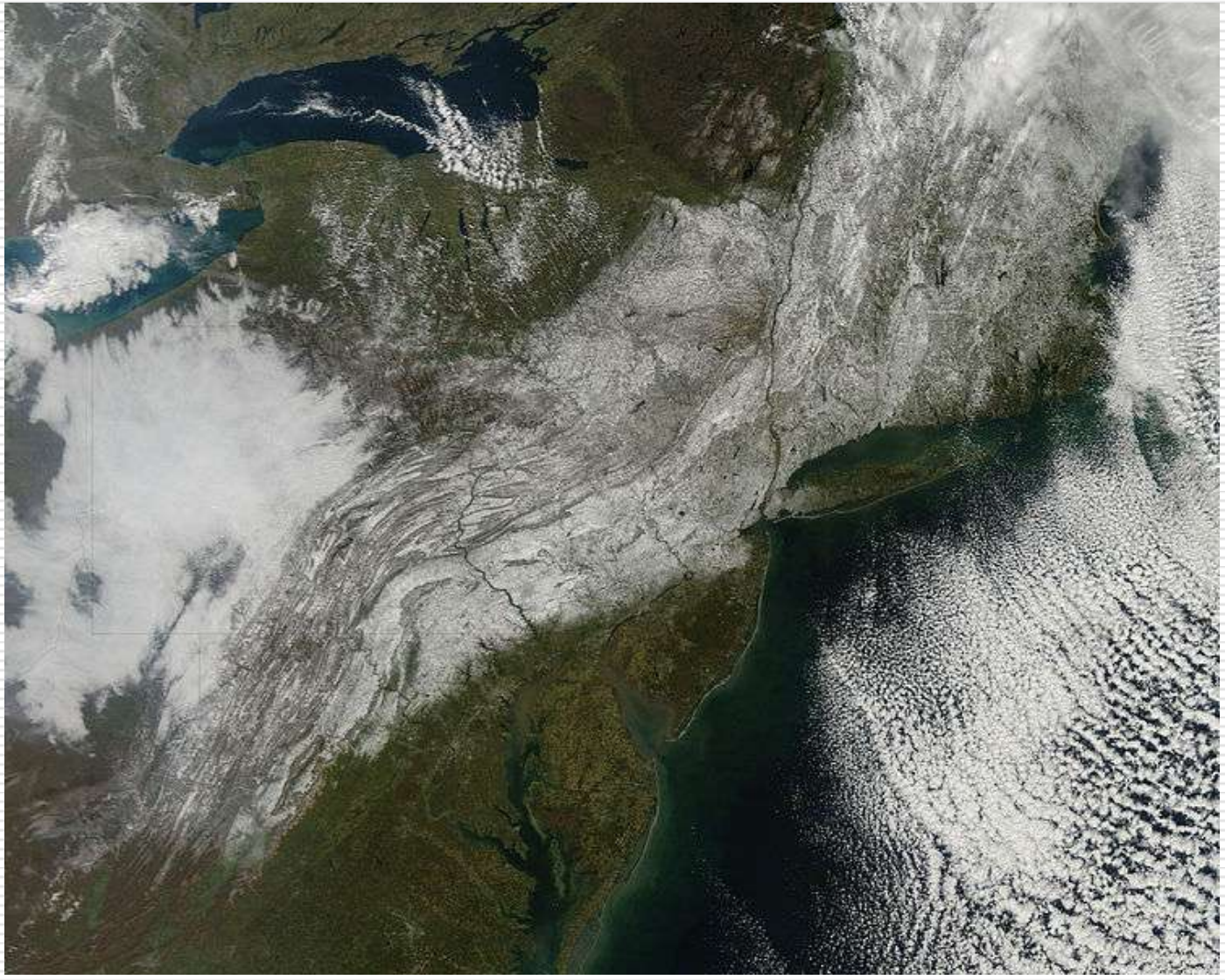
‘Snowtober Surprise’ – October 2011

'Snowtober Surprise' – October 2011

‘Snowtober Surprise – October 2011

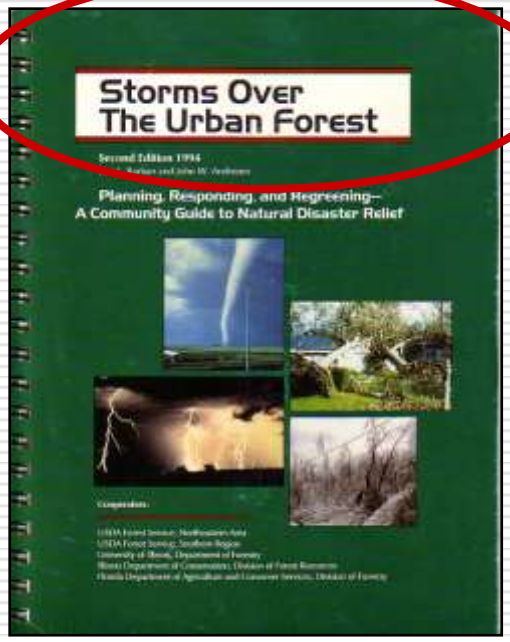


‘Snowtober Surprise – October 2011



On the ground response and action

On the ground response and action



Tree Emergency Plan Worksheet

For Urban and Community Foresters, Community Leaders, Public Works and Parks Departments, Planners, Councils, and other Public Officials

1. Early Warning System/Weather Forecasting Service — use an early warning procedure to enhance mitigation communicate with the National Weather Service, a consulting meteorological firm, a designated television weather channel, or the local police department. With a procedure in place, you should have an hours of lead time before most tree damaging weather strikes.

Staff Lead: _____

Contact Name: _____
Address: _____
Phone: _____
Mobile: _____
FAX: _____
Email: _____ Sub File: _____

Description of services provided:

2. Local Emergency Manager – Lead contact for a community and responsible for emergency planning and response activities.

Name: _____ Phone: _____
Mobile: _____
Role(s):

3. Public Relations Coordinator — This is the individual responsible for primary public relations, media contacts, citizen information and communications about the natural disaster. (Must have full knowledge of damage, community issues and capabilities, and be able to make decisions)

Name: _____ Phone: _____
Mobile: _____

Alternate(s):
Name: _____ Phone: _____
Mobile: _____
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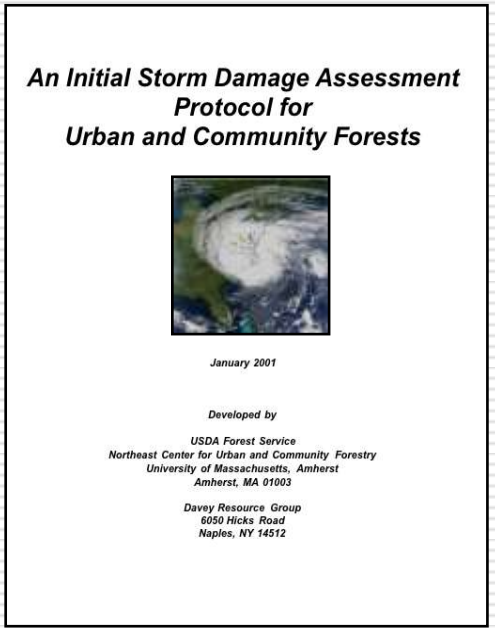

An Initial Storm Damage Assessment Protocol for Urban and Community Forests

January 2001

Developed by

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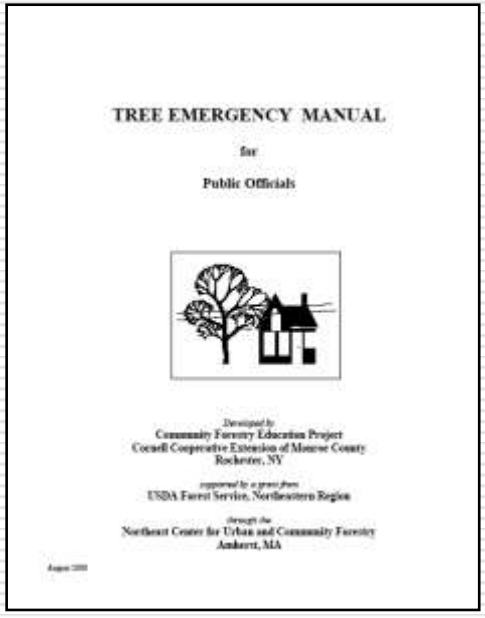
Northeast Center for Urban and Community Forestry
University of Massachusetts, Amherst
Amherst, MA 01003

Davey Resource Group
6050 Hicks Road
Naples, NY 14512



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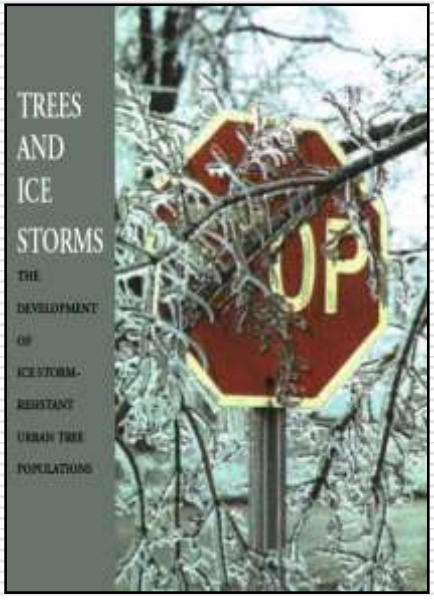
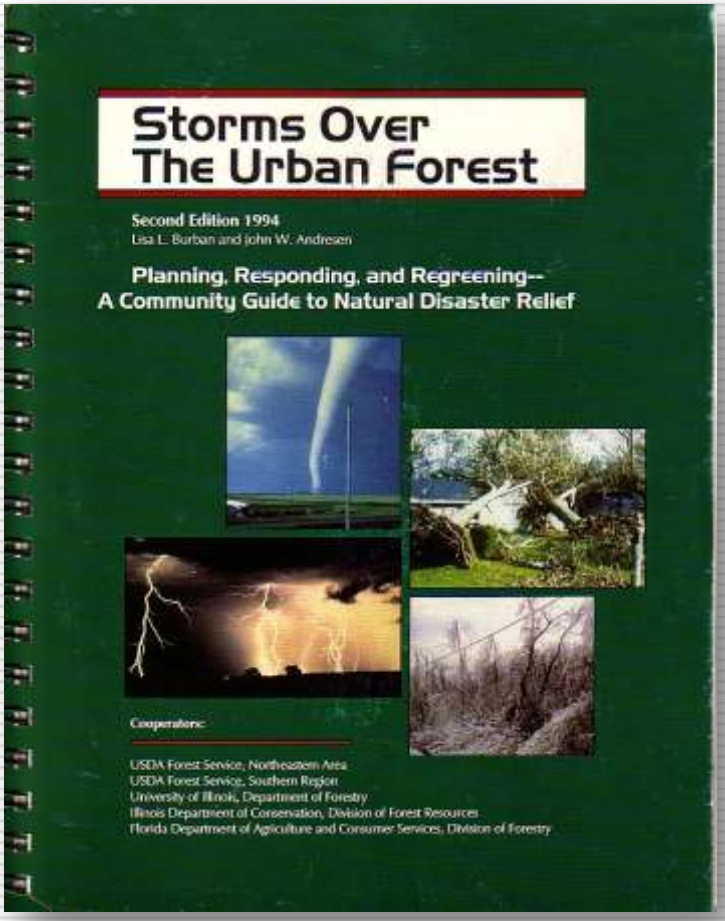
August 2000



Urban Tree Risk Management:

A Community Guide to Program Design and Implementation



Chapter 1 Introduction

Chapter 2 Coping with Natural Disasters

Chapter 3 Preparing for Natural Disasters

Chapter 4 Natural Disaster Alert, Response and Recovery

Chapter 5 Regreening the Community

Chapter 6 Approaches to Working With Disaster Relief Organizations

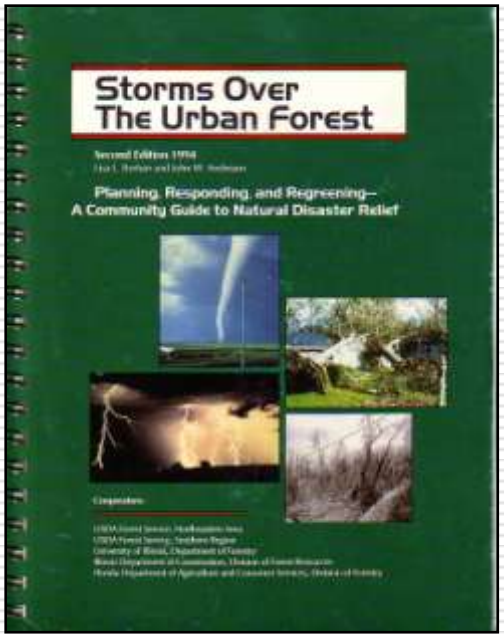
Chapter 7 Tornado Releaf - A Case Study

Chapter 8 Notes from Hurricane Andrew

Chapter 10 References

Chapter 11 Appendix - Key Words

http://www.na.fs.fed.us/urban



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For Urban and Community Foresters, Community Leaders, Public Works and Parks Departments, Planners, Councils, and other Public Officials

1. Early Warning System/Weather Forecasting Service — use of early warning procedures to enhance mitigation; communicate with the National Weather Service, a commercial meteorological firm, a subscription television weather channel, or the local police department. A good early warning system should have at least three hours of lead time before the onset of damaging weather strikes.

Staff Lead: _____

Contact Name: _____
Address: _____
Phone: _____
Mobile: _____
FAX: _____
Email: _____ Sub File: _____

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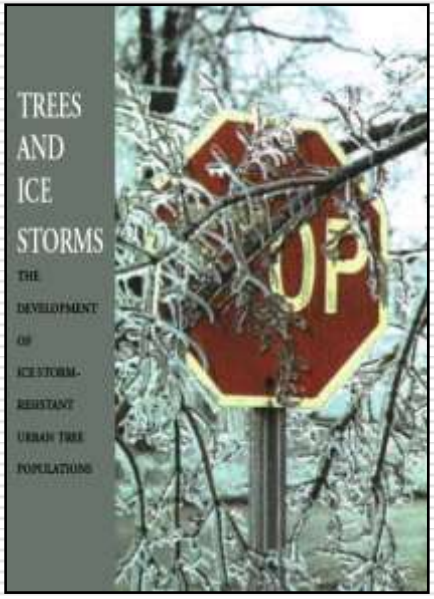

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State and Private Forestry

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Staff Lead: _____

Contact Name: _____
Address: _____
Phone: _____
Mobile: _____
FAX: _____
Email: _____ **Web Site** _____

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Name: _____ **Phone:** _____
Mobile: _____

Alternate(s):
Name: _____ **Phone:** _____
Mobile: _____
Name: _____ **Phone:** _____
Mobile: _____

http://www.na.fs.fed.us/urban

Tree Emergency Plan Worksheet

6. Emergency Call Out Procedure — phone contact tree for staff.

Name: ____________ Will Contact — Name: ____________
Phone: ____________
Mobile: ____________

Name: ____________
Phone: ____________
Mobile: ____________

Name: ____________
Phone: ____________
Mobile: ____________

Name: ____________ Will Contact — Name: ____________
Phone: ____________
Mobile: ____________

Name: ____________
Phone: ____________
Mobile: ____________

Name: ____________
Phone: ____________
Mobile: ____________

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Phone: ____________
Mobile: ____________

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Mobile: ____________

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Mobile: ____________

Name: ____________
Phone: ____________
Mobile: ____________

Name: ____________
Phone: ____________
Mobile: ____________

http://www.na.fs.fed.us/urban

Tree Emergency Plan Worksheet

11. Procedure for Debris Staging and Removal — Identify several areas for staging and processing debris. Establish a contract or agreement securing each site. Choose a processing site that is large, flat, well-drained and accessible to roads that can support truck weights of at least 9 tons per axle. Identify ways to protect significant trees or cultural resources during processing. Potential sites include undeveloped park, industrial, cemetery, fairgrounds, agency and state land. Large parking lots (even paved lots) work well. Remember to consider noise implications near residential areas. Identify multiple sites. Annually reconfirm access and availability to these sites. Make sure the site is large enough for safety considerations (flying debris from tub grinders). If possible, identify sites that can be secured (fencing).

Site 1 – Location: _____

Contact Name/Role:

Phone: Mobile:

Site 2 – Location: _____

Contact Name/Role:

Phone: Mobile:

Site 3 – Location: _____

Contact Name/Role:

Phone: Mobile:

12. Debris and Brush Removal from Private Property — Identify how you will address this issue. A major storm makes it difficult for private property owners to remove brush and debris. Make a decision at the municipal level allowing for debris collection. Determine if your city has adequate equipment and staff available to accomplish this often enormous task. It is critical that you provide guidelines for residents. Specify the types, amounts and piling arrangement of the materials that you will accept. Cities can also assist private homeowners who must contract with private companies for trimming and removal by preparing a list of companies that are licensed, professionally trained and insured.

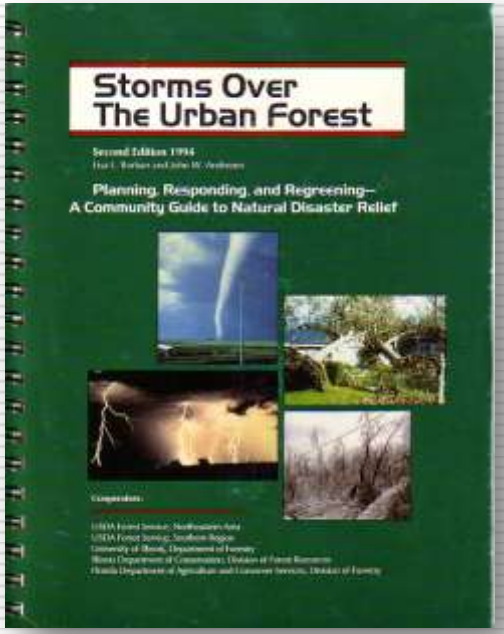
Person Responsible: _____
Phone: _____ **Mobile:** _____

Minor Storm Policy:

Major Storm Policy:

Listing of available tree care companies:

http://www.na.fs.fed.us/urban



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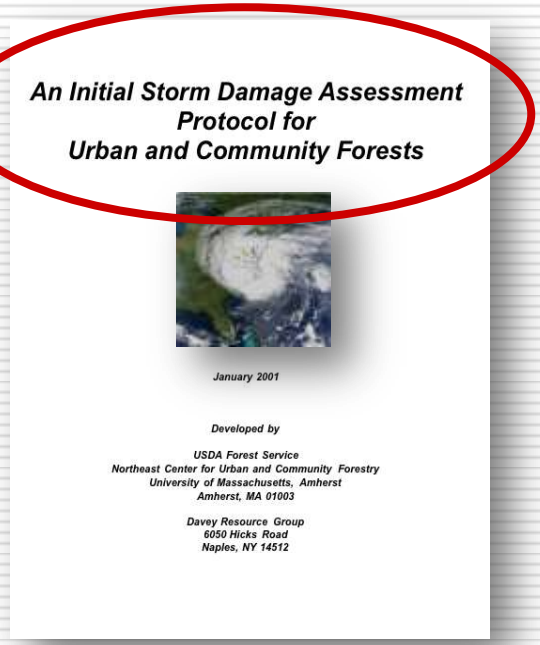

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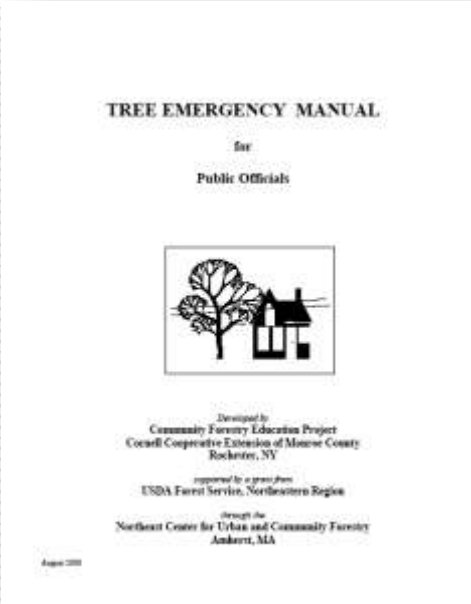

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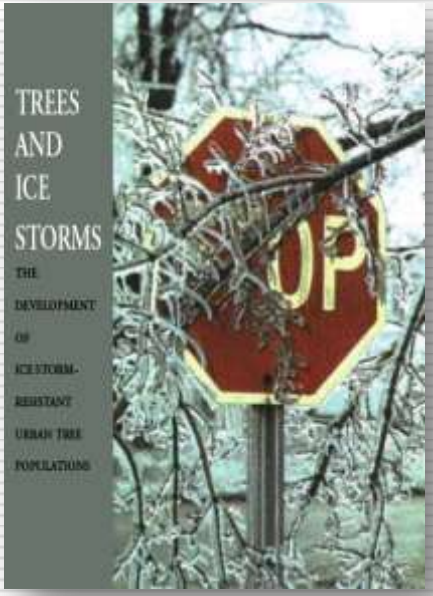


Estimating Storm Damage Costs

What is i-Tree?

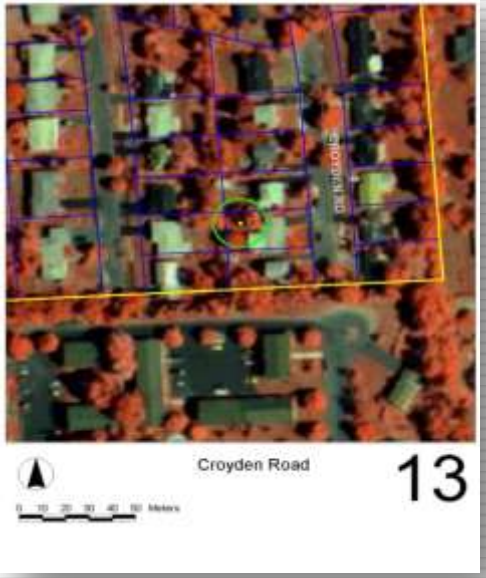
A suite of tools to assess urban vegetation and their ecosystem services and values

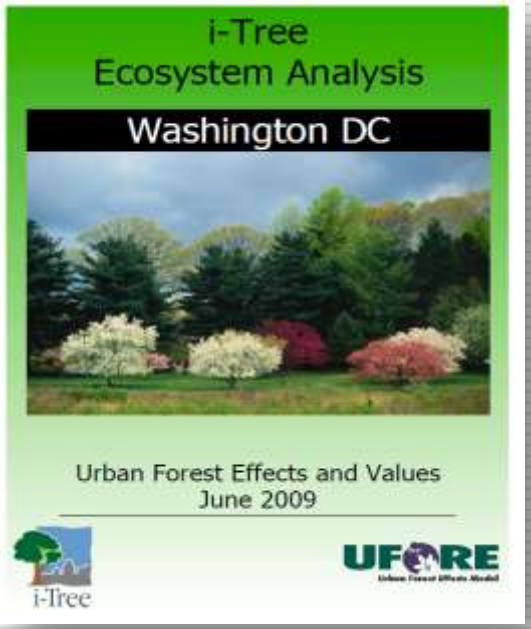
Public-Private Partnership

- USDA Forest Service
- Davey Tree Expert Co.
- National Arbor Day Foundation
- Society of Municipal Arborists
- International Society of Arboriculture
- Casey Trees

Goals

- Simple and low-cost tools and methods to aid in forest planning and management
- Complete process – start to finish





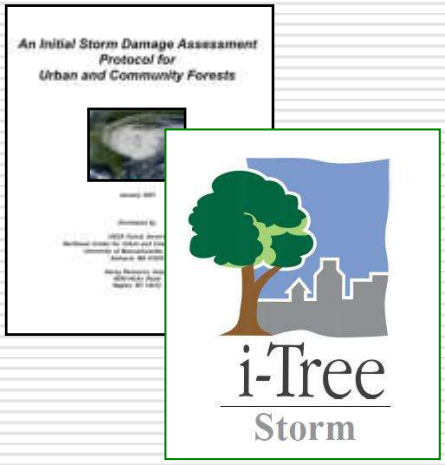
How Does Storm Work?

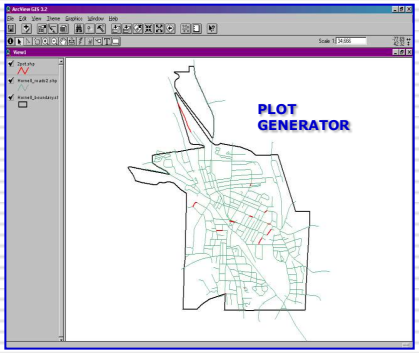
- Context of Use
- Sampling
- Data Collection
- PDA & Desktop Features

Context of Use

- Planning
  - Framed by overall natural disaster plan
    - FEMA funding: Pre-Disaster Mitigation Program
    - Tree Emergency Plan Worksheet (Burban)
- Recovery
  - First 24-36 hours
  - Response to state emergency agency

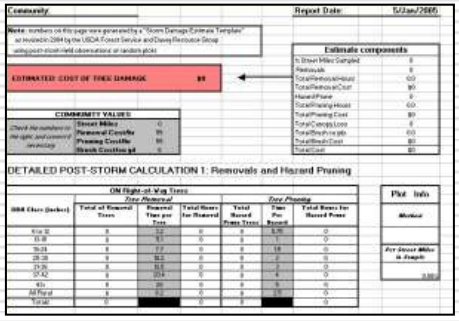
The SDAP Process



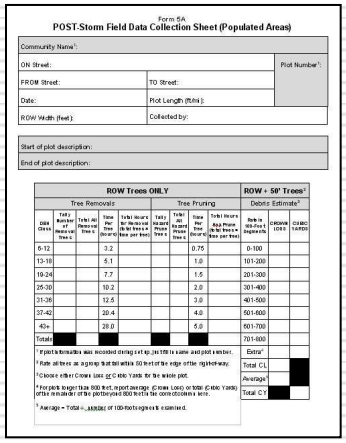


Random Plots

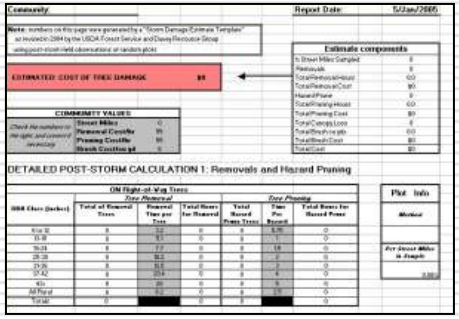
Pre-Storm Sample Survey



Estimating Engine



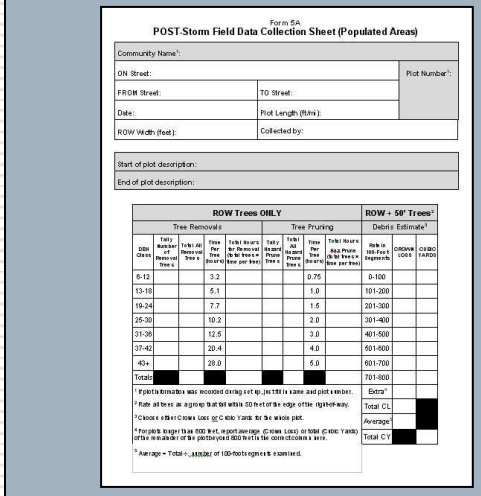
Post-Storm Survey



Final Damage Estimate

Components

i-Tree Storm



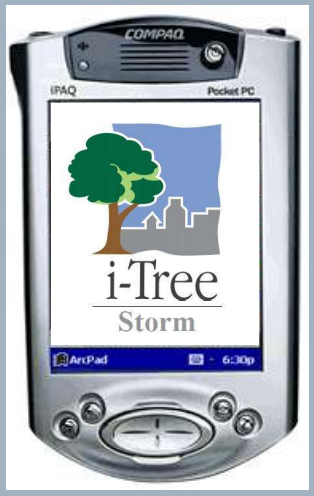
Form 5A
POST-Storm Field Data Collection Sheet (Populated Areas)

Community Name[1]:	
ON Street:	Plot Number[1]:
FROM Street:	TO Street:
Date:	Plot Length (ft/mi):
ROW Width (feet):	Collected by:
Start of plot description:	
End of plot description:	

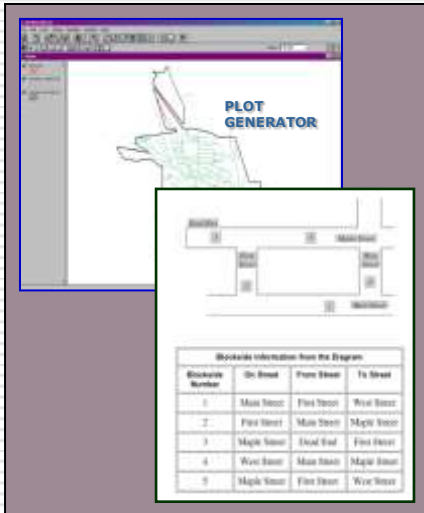
ROW Trees ONLY								ROW + 50' Trees[2]		
Tree Removals					Tree Pruning			Debris Estimate[3]		
DBH Class	Tally Number of Removal Trees	Total All Removal Trees	Time Per Tree (hours)	Total Hours for Removal (Total Trees x Time per Tree)	Tally Hazard Prune Trees	Total All Hazard Prune Trees	Time Per Tree (hours)	Total Hours Avg Prune (Total Trees x Time per Tree)	Rate in 100-Foot Segments	CROWN LOSS	CUBIC YARDS
0-12			3.2				0.75		0-100		
13-18			5.1				1.0		101-200		
19-24			7.7				1.5		201-300		
25-30			10.2				2.0		301-400		
31-36			12.5				3.0		401-500		
37-42			20.4				4.0		501-600		
43+			28.0				5.0		601-700		
Totals									701-800		
									Extra[4]		
									Total CL		
									Average[5]		
									Total CY		

[1] If plot information was recorded during set up, just fill in name and plot number.
[2] Rate all trees as a group that fall within 50 feet of the edge of the right-of-way.
[3] Choose either Crown Loss or Cubic Yards for the whole plot.
[4] For plots longer than 500 feet, report average (Crown Loss) or total (Cubic Yards) of the remainder of the plot beyond 500 feet to the correct decimal place.
[5] Average = Total ÷ number of 100-foot segments examined.

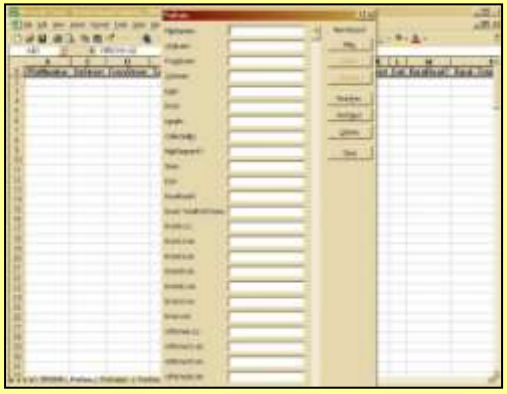
Data Collection- Paper



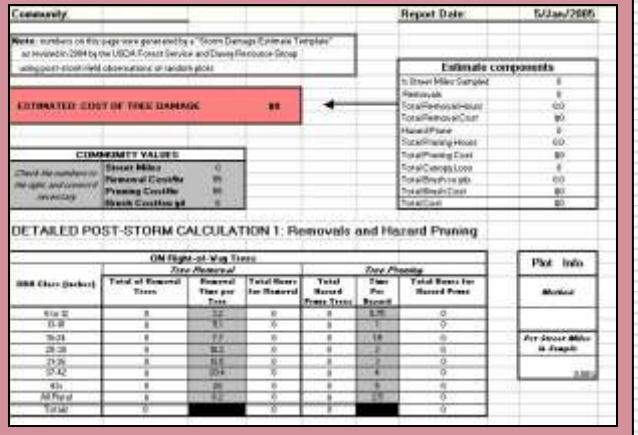
Data Collection- PDA



Sampling Tools



Data Storage & Processing

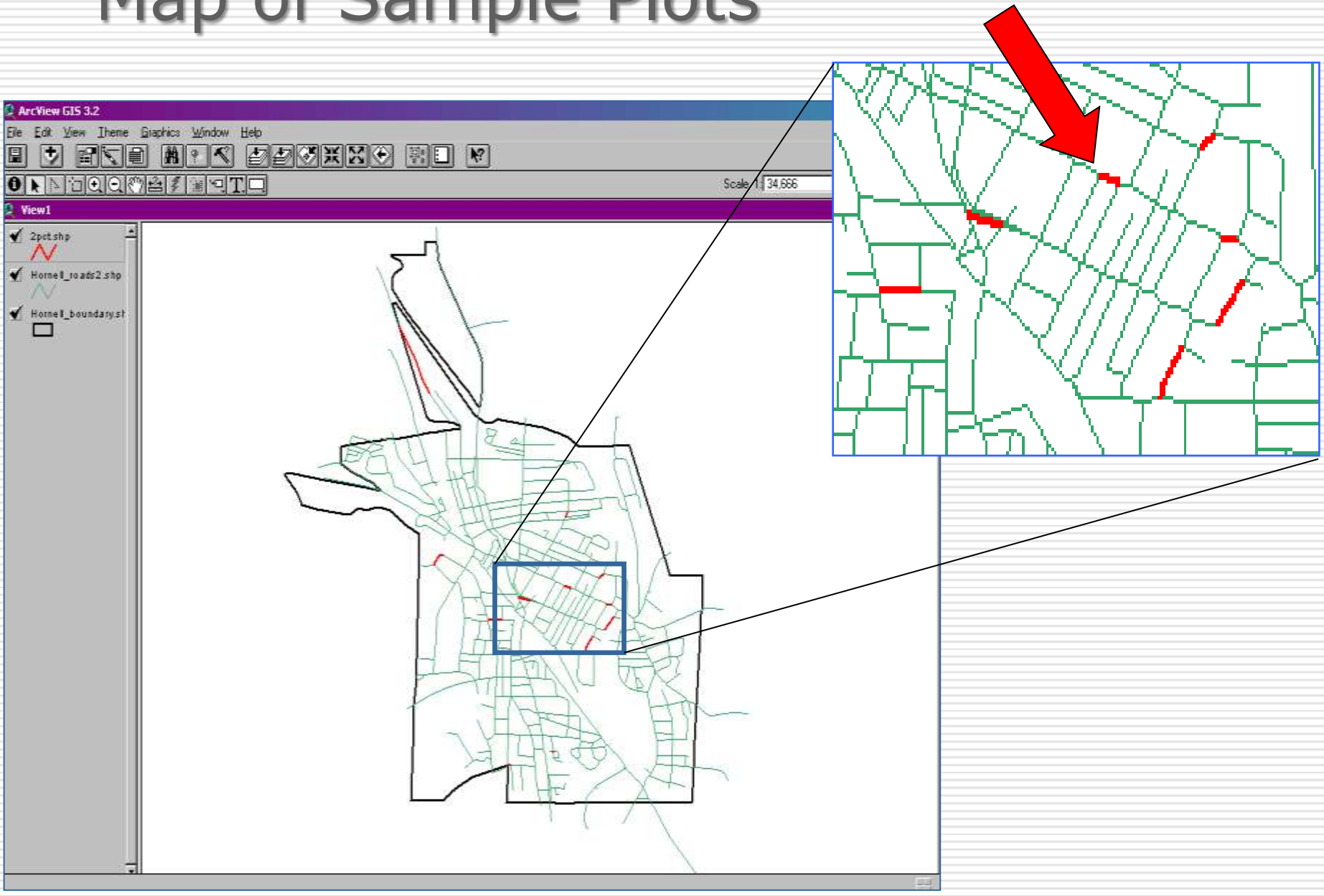


Reporting

Sampling Methods

- 2-3% of blockside mileage
  - Blockside = street segment between road/street corners or ends
- Manual Method or Computerized Process
  - Random selection
  - 10 blockside minimum needed for analysis

Map of Sample Plots



Data Collection

Form 5A

POST-Storm Field Data Collection Sheet (Populated Areas)

Community Name[1]:		
ON Street:		Plot Number[1]:
FROM Street:	TO Street:	
Date:	Plot Length (ft/mi):	
ROW Width (feet):	Collected by:	

Start of plot description:
End of plot description:

ROW Trees ONLY									ROW + 50' Trees[2]		
Tree Removals					Tree Pruning				Debris Estimate[3]		
DBH Class	Tally Number of Removal Trees	Total All Removal Trees	Time Per Tree (hours)	Total Hours for Removal (total trees × time per tree)	Tally Hazard Prune Trees	Total All Hazard Prune Trees	Time Per Tree (hours)	Total Hours Haz Prune (total trees × time per tree)	Rate in 100-Foot Segments	CROWN LOSS	CUBIC YARDS
6-12			3.2				0.75		0-100		
13-18			5.1				1.0		101-200		
19-24			7.7				1.5		201-300		
25-30			10.2				2.0		301-400		
31-36			12.5				3.0		401-500		
37-42			20.4				4.0		501-600		
43+			28.0				5.0		601-700		
Totals									701-800		
									Extra[4]		
									Total CL		
									Average[5]		
									Total CY		

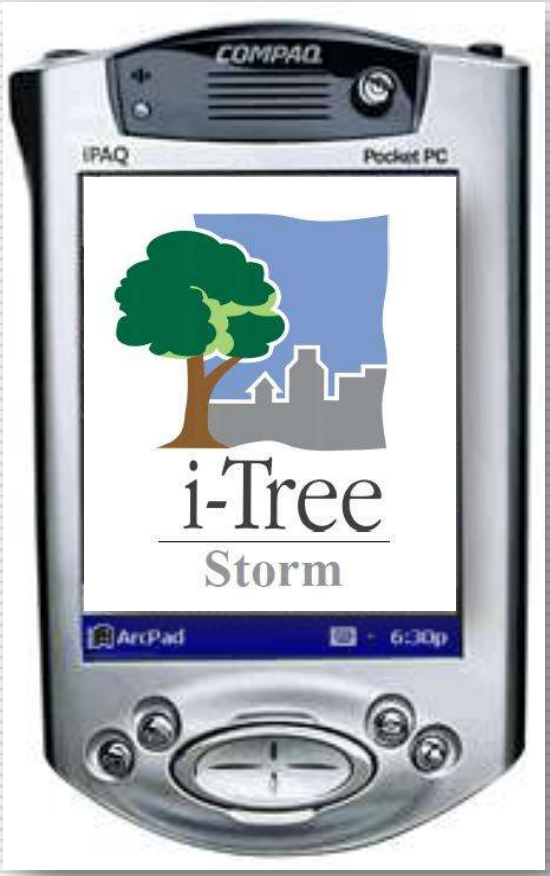
[1] If plot information was recorded during set up, just fill in name and plot number.

[2] Rate all trees as a group that fall within 50 feet of the edge of the right-of-way.

[3] Choose either Crown Loss or Cubic Yards for the whole plot.

[4] For plots longer than 800 feet, report average (Crown Loss) or total (Cubic Yards) of the remainder of the plot beyond 800 feet in the correct column here.

[5] Average = Total ÷ number of 100-foot segments examined.

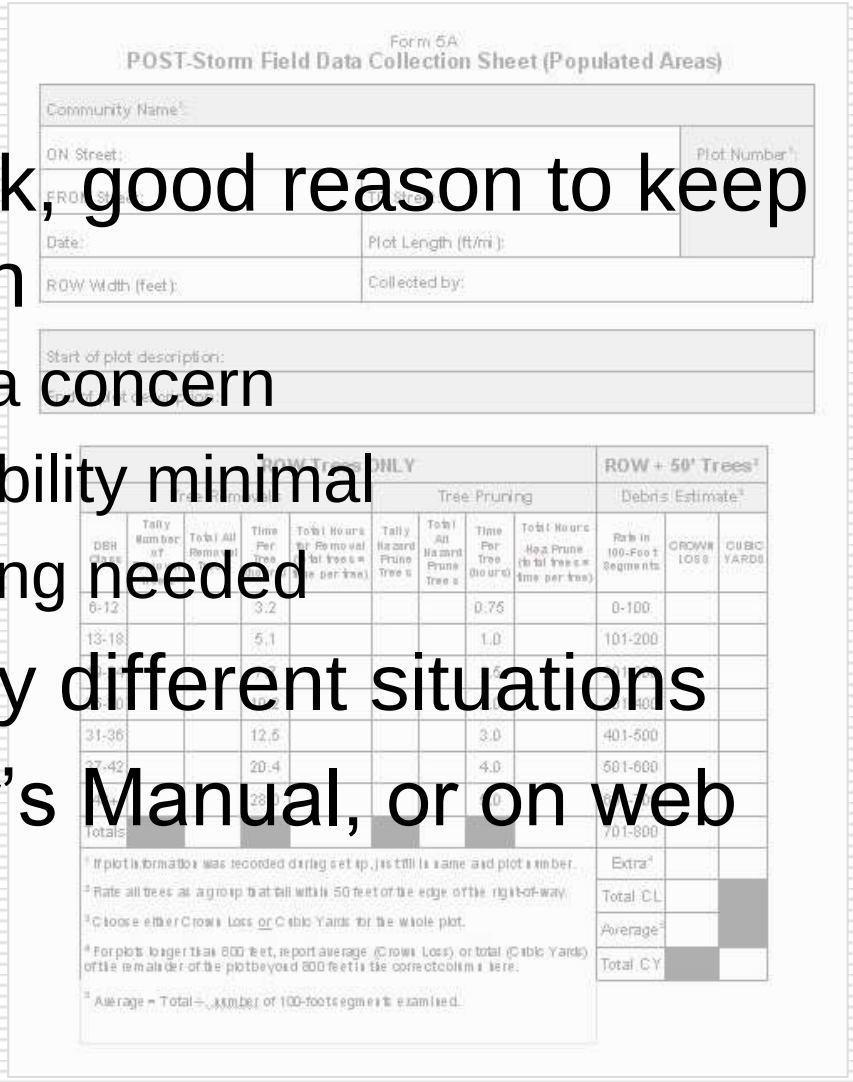


Overview: Pre-storm setup

- Create random sample
  - Before emergency!
  - Use electronic or manual means
- Measure tree density and size class
  - Within ROW
  - Also 50’ back from ROW edge
- Take final steps
  - Pre-Storm report form: useful estimate
  - Storage for future use

Data collection: paper forms

- In disaster work, good reason to keep paper as option
  - Electricity not a concern
  - Damage possibility minimal
  - Reduces training needed
- Forms for many different situations
- Copies in User's Manual, or on web



Form 5A
POST-Storm Field Data Collection Sheet (Populated Areas)

Community Name[1]:

ON Street:

FROM Cross Street:

Plot Number[1]:

Date:

Plot Length (ft/mi):

ROW Width (feet):

Collected by:

Start of plot description:

ROW Trees ONLY

ROW + 50' Trees[2]

Tree Pruning

Debris Estimate[3]

DBH Range	Tally Number of Trees	Total All Removal	Time Per Tree	Total Hours for Removal (total trees x time per tree)	Tally Hazard Prune Trees	Total All Hazard Prune Trees	Time Per Tree (hours)	Total Hours Haz Prune (total trees x time per tree)	Rate in 100-Foot Segments	CROWN LOSS	CUBIC YARDS
6-12			3.2				0.75		0-100		
13-18			5.1				1.0		101-200		
19-24			8.1				2.0		201-300		
25-30			10.2				2.5		301-400		
31-36			12.5				3.0		401-500		
37-42			20.4				4.0		501-600		
43-48			25.0				5.0		601-700		
Totals									701-800		
									Extra[4]		
									Total CL		
									Average[5]		
									Total CY		

[1] If plot information was recorded during set up, just fill in same and plot number.

[2] Rate all trees as a group that fall within 50 feet of the edge of the right-of-way.

[3] Choose either Crown Loss or Cubic Yards for the whole plot.

[4] For plots longer than 800 feet, report average (Crown Loss) or total (Cubic Yards) of the remainder of the plot beyond 800 feet in the correct column here.

[5] Average = Total ÷ number of 100-foot segments examined.

Form 5A

POST-Storm Field Data Collection Sheet (Populated Areas)

Community Name[1]:		
ON Street:		Plot Number[1]:
FROM Street:	TO Street:	
Date:	Plot Length (ft/mi):	
ROW Width (feet):	Collected by:	

Start of plot description:
End of plot description:

ROW Trees ONLY									ROW + 50' Trees[2]		
Tree Removals					Tree Pruning				Debris Estimate[3]		
DBH Class	Tally Number of Removal Trees	Total All Removal Trees	Time Per Tree (hours)	Total Hours for Removal (total trees x time per tree)	Tally Hazard Prune Trees	Total All Hazard Prune Trees	Time Per Tree (hours)	Total Hours Haz Prune (total trees x time per tree)	Rate in 100-Foot Segments	CROWN LOSS	CUBIC YARDS
6-12			3.2				0.75		0-100		
13-18			5.1				1.0		101-200		
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37-42			20.4				4.0		501-600		
43+			28.0				5.0		601-700		
Totals									701-800		
									Extra[4]		
									Total CL		
									Average[5]		
									Total CY		

[1] If plot information was recorded during set up, just fill in name and plot number.

[2] Rate all trees as a group that fall within 50 feet of the edge of the right-of-way.

[3] Choose either Crown Loss or Cubic Yards for the whole plot.

[4] For plots longer than 800 feet, report average (Crown Loss) or total (Cubic Yards) of the remainder of the plot beyond 800 feet in the correct column here.

[5] Average = Total ÷ number of 100-foot segments examined.

Form 5B

POST-Storm Field Data Collection Sheet (Rural Areas)

Community Name[1]:		
ON Road:		Plot Number[1]:
Intersection nearest to plot start:		
Approximate distance to intersection:		
Date:	Plot Length (feet):	
ROW Width (feet):	Collected by:	

Start of plot:
End of plot:

ON Right-of-Way Trees (Count trees on both sides of the road)							
Tally of hazardous removal ROW trees	Total Number of hazardous removal ROW Trees	Avg. Time[2] per Removal	Total Hours Removal (total trees x time per removal)	Tally of hazardous prune ROW trees	Total Number of hazardous prune ROW trees	Avg. Time[3] Per Prune	Total Hours Hazard Prune (total trees x time per prune)
		6.2				2.5	
Totals							

Debris estimate[4]		
Rate in 100-Foot Segments	Crown Loss	Cubic Yards
0-100		
101-200		
201-300		
301-400		
401-500		
501-600		
601-700		
701-800		
Extra[5]		
Total CL		
Average[6]		
Total CY		

[1] If road and plot information was recorded during set up, just fill in name and plot number.

[2] On rural roads, removals are only recorded for large trees already in failure. Time has been reduced 50% from the urban rate, and excludes stump removal.

[3] On rural roads, time per prune is for pruning of broken or hazardous branches greater than 4 inches only. Time has been reduced 50% from urban rate, and does not include other pruning.

[4] Choose Crown Loss or Cubic Yards for the plot. Estimate Crown Loss with one of these values: 12.5 (0-25%), 37.5 (26-50%), 62.5 (51-75%), or 87.5 (76-100%).

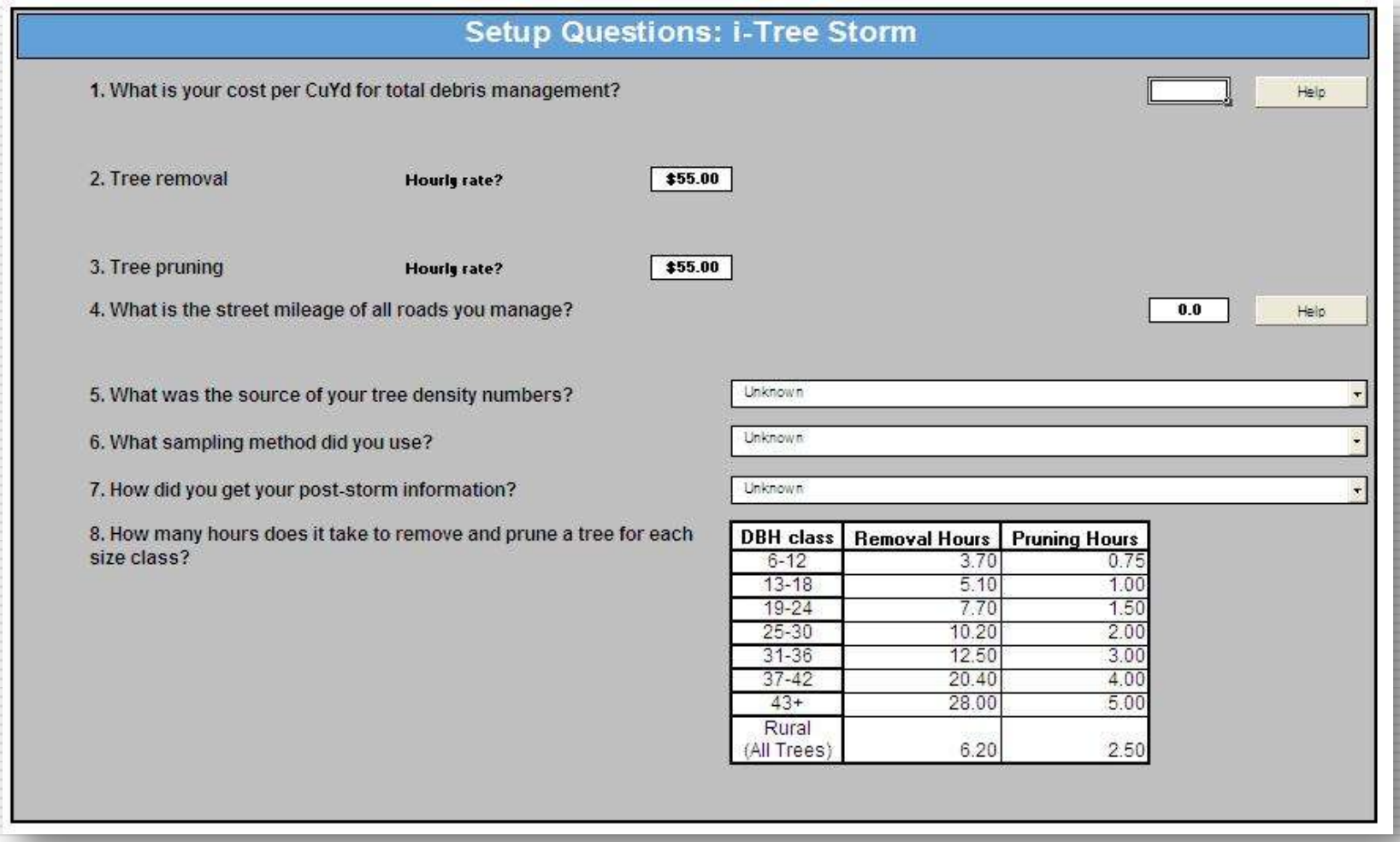
[5] For plots longer than 800 feet, report average (Crown Loss) or total (Cubic Yards) of the rest of the plot beyond 800 feet in the correct column here.

[6] Average = Total CL ÷ # of 100' segments

Data Collection: Desktop Interface

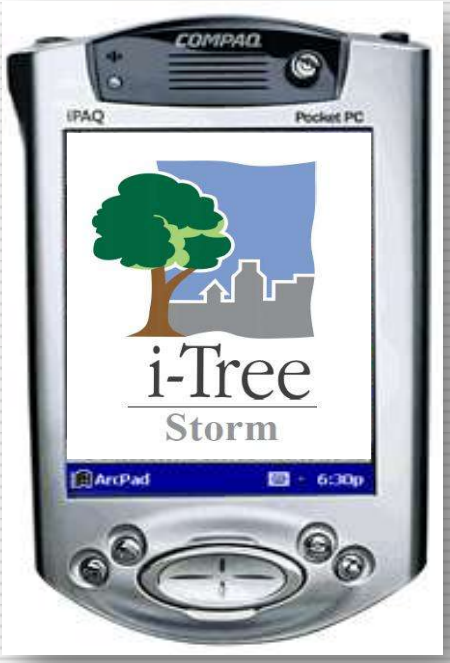
- Manage Users
- Community Values
- Reference Data
  - TIGER
  - manual
- ROW Info
- Export Data

Data Collection: Desktop Interface



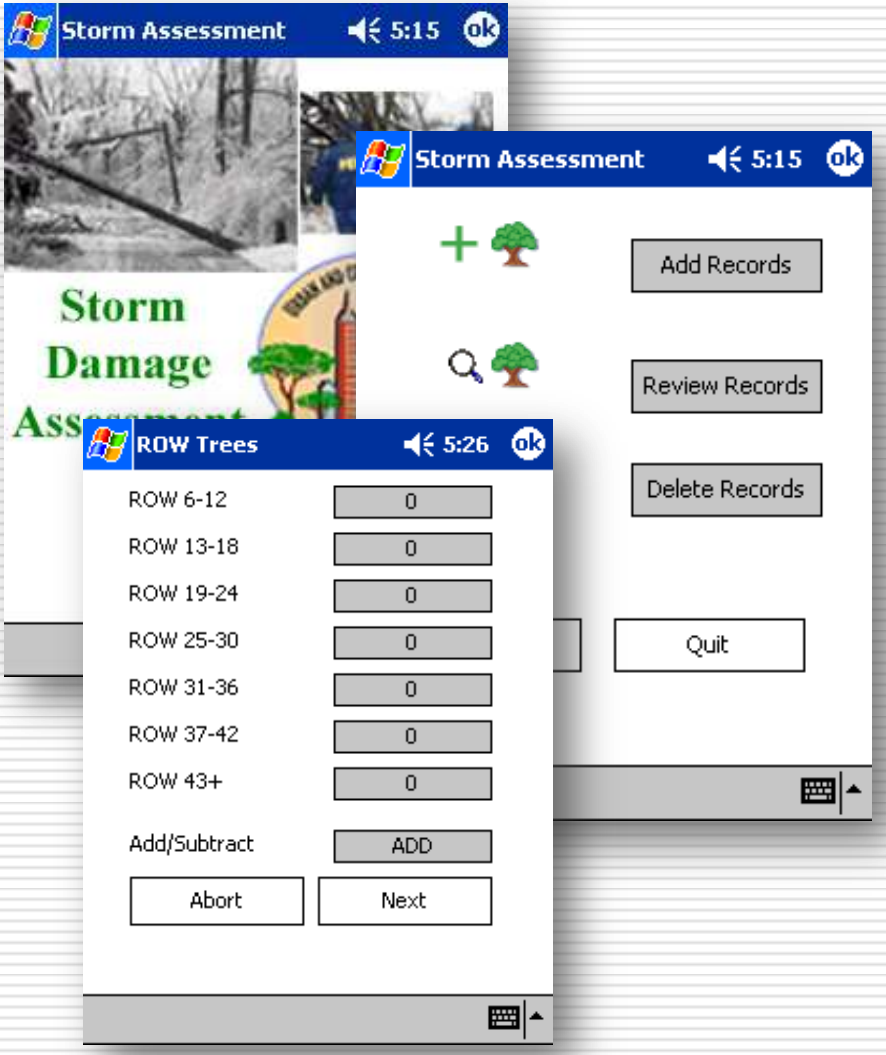
PDA Setup Interface

- Management of process, data and applications
- Simple, intuitive



Data collection: PDA

- Installed on handheld through Start menu
- Data uploaded automatically during synchronization



Estimating Costs

i-Tree Storm

Community: Burlington

Report Date: 22-Jul-09

This report was generated by i-Tree Storm v3.0.

Source: http://www.itreetools.org

COMMUNITY VALUES			Sampling
Correct numbers to right as needed	Street Miles	125.0	TL
	Removal Cost/hr	$55.00	
	Pruning Cost/hr	$55.00	% Street Miles
	Brush Cost/cu yd	$15.00	1.6%
Based on Sample Data	Tree density per 100' (ROW + 50')	5.6	No. Samples
Precision Level *	Low		20

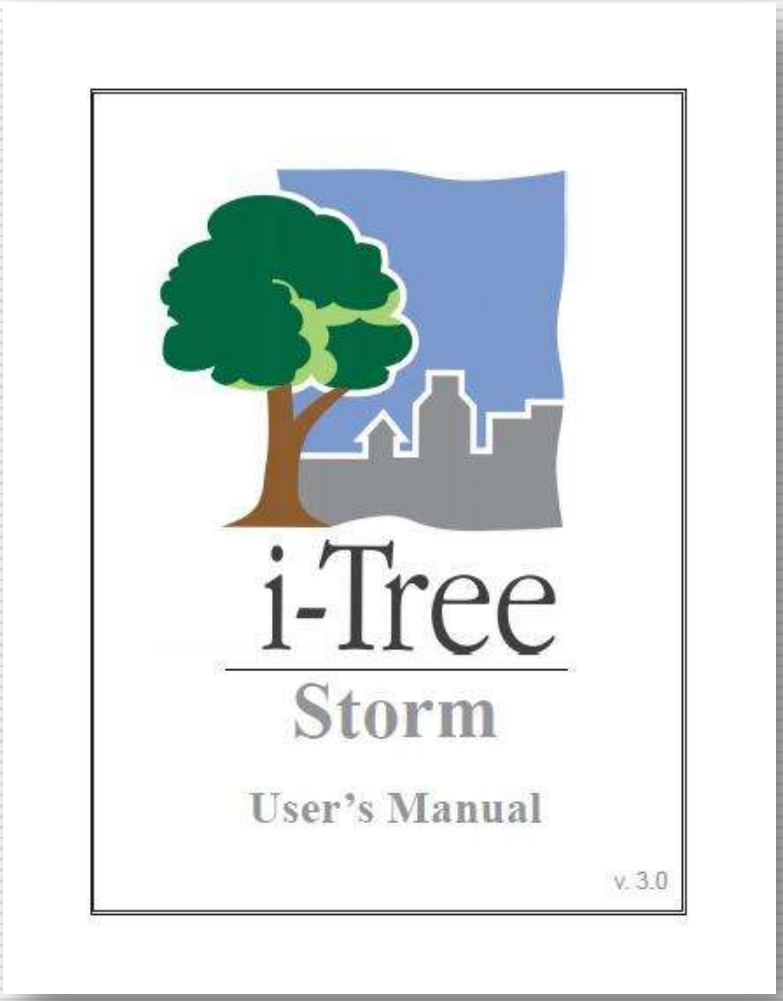
** Precision Level indicates overall reliability of input data (see User's Manual)*

STORM DAMAGE COST ESTIMATE	$10,079,769	
Component	Estimate	± SE *
Removals	94,240	832
Total Removal Hours	94,240	10,852
Total Removal Cost	$5,183,174	$596,865
Hazard Prune	7,100	665
Total Pruning Hours	14,769	1,407
Total Pruning Cost	$812,322	$77,397
Total Debris cu yds	272,285	27,155
Total Debris Cost	$4,084,273	$407,325

** SE of Total Debris cu yds is calculated only on direct CY estimates; crown loss estimates are ignored*

DETAILED POST-STORM CALCULATION: Hazard Removal and Pruning

	ON Right-of-Way Trees							
	Hazard Tree Removal				Hazard Tree Pruning			
DBH Class (inches)	Total of Removal Trees	Removal Time per Tree	Total Hours for Removal	Total Hours SE	Total of Prune Trees	Hazard Prune Time per Tree	Total Hours for Hazard Prune	Total Hours SE
6-12	9	3.70	33.3	±19.11	8	0.75	6.0	±1.35
13-18	29	5.10	147.9	±29.67	26	1.00	26.0	±5.76
19-24	25	7.70	192.5	±38.47	24	1.50	36.0	±7.87
25-30	31	10.20	316.2	±56.31	23	2.00	46.0	±10.02
31-36	24	12.50	300.0	±52.68	12	3.00	36.0	±9.36
37-42	12	20.40	244.8	±103.78	12	4.00	48.0	±11.48
43+	9	28.00	252.0	±99.33	7	5.00	35.0	±8.73
All Rural	0	6.20	0.0	±0.00	0	2.50	0.0	±0.00
Totals	139		1486.7	±171.20	112		233.0	±22.20



Storm User's Manual

Storm User's Manual

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What kinds of storms do you anticipate? Ice storms, hurricanes and floods, smaller-scale disasters?

Different disaster types present different damage and debris profiles, requiring some adjustment to the use of Storm.

Ice Storms: Ice storms tend to have relatively widespread and uniform damage, and the debris is almost exclusively vegetative. Furthermore, the ice-laden debris usually remains at its initial landing place and is not moved around by natural forces. These characteristics permit quick, accurate estimates of potential and actual damage and costs from a small random sample.

What Type of Storm?

Hurricanes and floods: Hurricanes and many floods also produce widespread damage, and Storm will work well to produce a quick estimate of actual damage and costs. A Hurricane Adaptation has been incorporated into Storm that makes use of actual data and practices from a 10% random sample of communities in Florida following the 2004-2005 hurricane seasons. For pre-storm assessments, the Hurricane Adaptation version (beta) predicts average vegetative debris loads based on street mileage and a choice of three damage levels. Because general averages are used, the estimates tend to be more accurate at the larger scale than at the very local level.

What Type of Storm?

Smaller-Scale Disasters: Smaller-scale disasters, including tornados, derechos (straight-line storms associated with thunderstorms), and some floods, present sampling problems since they affect smaller areas. To estimate the damage caused by smaller-scale disasters, the following procedure may be used:

Determine the rough geographic area affected by the disaster. It may be necessary to assess this based on a quick survey of the area, for example, by driving toward the area from different directions and noting where the damage begins, or by using aerial data if available.

Draw a boundary around the affected area on a street map or in the GIS file used for sampling.

Determine the total street miles in the affected area using the scaled map or standard GIS tools.

Establish a suitable sample of the street segments in the area.

What Type of Storm?

Does your community include rural (unpopulated) roads?

Data collection for rural roads differs slightly from data collection in populated areas. This is mainly because in populated areas FEMA will reimburse costs for debris that can be hauled to the curbside by residents, so trees 50 ft beyond the right-of-way are included in estimations of potential debris. There are manual forms specifically for rural areas and rural plots can be identified in the plot list and PDA.

Rural Roads?

Springfield Massachusetts
June 1, 2011 Tornado

Northern
RESEARCH STATION
USDA Forest Service

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

INFORMATIONAL BRIEF

3.0

June 23, 2011

Kipling Street
East Forest Park
Springfield, MA

Tornado Damage Quick Facts

Impacts on Springfield's Street Trees

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. In Springfield, the tornados impacted city's South End, Six Corners, East Forest Park and Sixteen Acres neighborhoods.

In the neighborhoods of Springfield affected by the storms, damage to the street trees was extensive, destroying or severely 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.

A preliminary review of the storm damage to Springfield public street trees follows here:

- 87 miles of the 540 total miles of city streets were impacted by the storms;
- 16.1 % of Springfield's streets showed some damage to the public trees growing on them;
- Approximately 1,340 of the 3,830 streets trees, growing in the impacted areas, were destroyed or severely damaged, necessitating removal;
- Immediate impacts include the reduction of rainwater interception by 2,444,252 gallons;
- Reduced storage of 7,220,361 pounds of carbon;
- Approximately 331,232 pounds of sequestered CO^2 has been lost.

For more information please contact:

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Amherst, MA
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Alexander R. Sherman
City of Springfield
Assistant City Forester
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i-Tree Streets Analysis of Springfield Tornado Impact Zone

i-Tree™
Streets

Annual Loss in Benefits of Springfield's Street Trees

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

i-Tree Streets

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

i-Tree™
Streets

INFORMATIONAL BRIEF

July 7, 2011

Arcadia Boulevard Springfield, MA

Tornado Damage Quick Facts

Impacts on Springfield's Urban Forest

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. In Springfield, the tornados impacted city's South End, Six Corners, East Forest Park and Sixteen Acres neighborhoods.

In the neighborhoods of Springfield affected by the storms, damage to the urban forest canopy was extensive, destroying or severely many of the trees growing in these areas. A team of US Forest Service and City of Springfield personnel conducted a preliminary review of the streets in the impacted neighborhoods, and utilized i-Tree modeling software to analyze the impacts of the storms on the urban forest, and an initial summary of the damage n was developed.

A preliminary review of the storm damage to Springfield's urban tree canopy follows here:

- Based on initial estimates, over 13,000 trees were destroyed or severely damaged;
- Immediate impacts include the reduction of rainwater interception by over 7.5 million gallons per year;
- Reduced storage of over 30 million pounds of carbon annually;
- Approximately 1.4 million pounds of sequestered CO^2 has been lost.

Northern Research Station

For more information please contact:

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dbloniarz@fs.fed.us

Alexander R. Sherman
City of Springfield
Assistant City Forester
arsherma@eco.umass.edu

Canopy Analysis of Springfield Tornado Zone

i-Tree™

Canopy

i-Tree Canopy Analysis of Springfield Tornado Zone

- Based on initial estimates, over 13,000 trees were destroyed or severely damaged;
- Immediate impacts include the reduction of rainwater interception by over 7.5 million gallons per year;
- Reduced storage of over 30 million pounds of carbon annually;
- Approximately 1.4 million pounds of sequestered CO2 has been lost.

SPRINGFIELD TORNADO IMPACTS ON TREE CANOPY, TEMPERATURE & HUMIDITY

Fall 2011
USDA Forest Service
Northern Research Station

TREE CANOPY LOSS IN THE TORNADO IMPACT ZONE WAS EXTENSIVE, WITH MANY LARGE SHADE TREES DESTROYED.

The June 2011 Massachusetts tornado profoundly altered the landscape over a wide geographic area.

On June 1, 2011 a series of tornadoes ripped through Western Massachusetts, and included the second strongest tornado ever recorded in Massachusetts, with wind speeds estimated at 166 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 69 miles from Westfield to Charlton, killing three people and injuring 200. In Springfield, the tornados impacted city's South End, Upper Hill, Metro Center, Six Corners, East Forest Park and Sixteen Acres neighborhoods.

CANOPY LOSS

TREE FAILURE

STRUCTURE DAMAGE

Micro-climate Changes in Springfield's Tornado Zone

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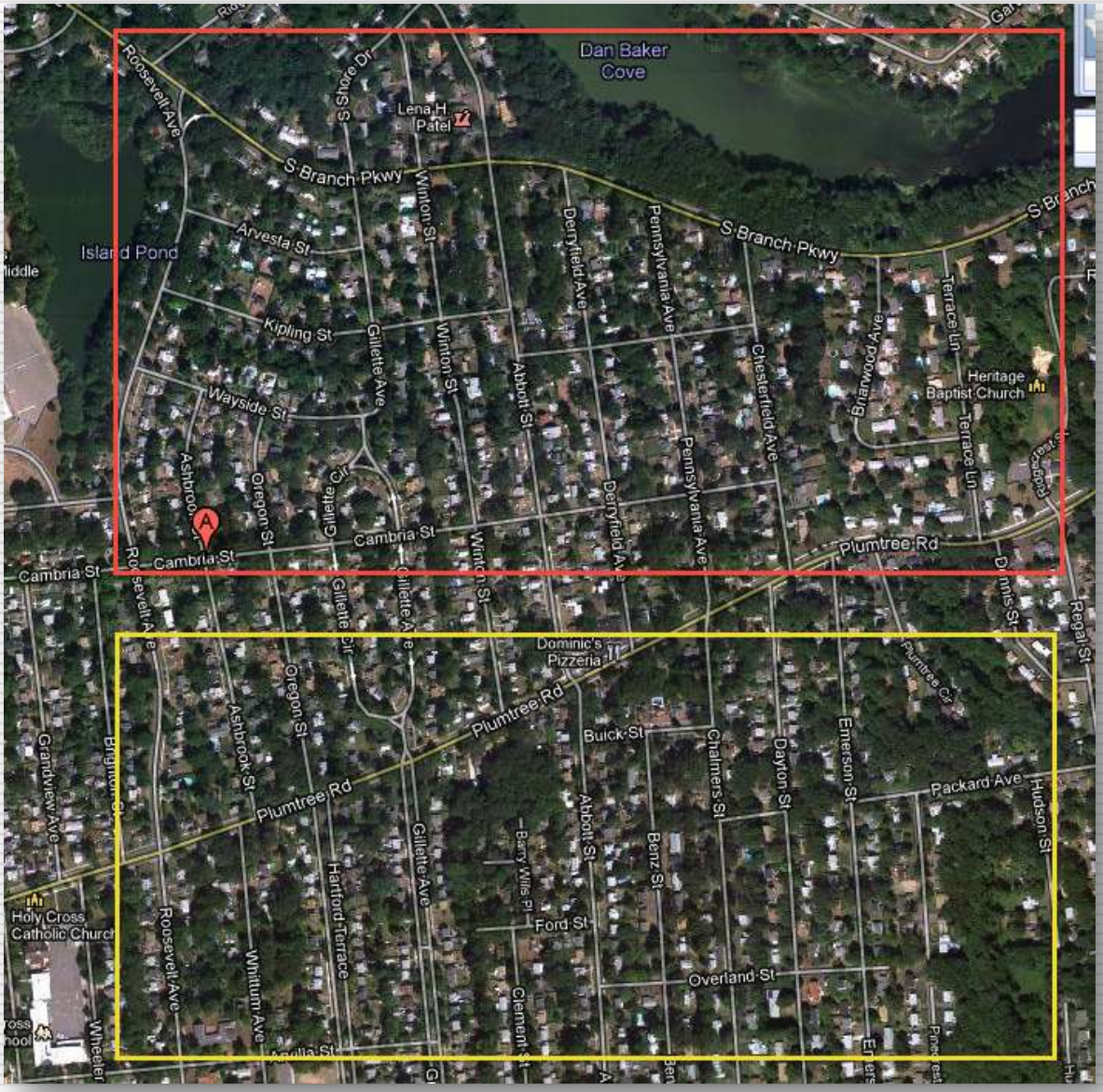
DEPARTMENT OF AGRICULTURE



Micro-climate Changes in Springfield's Tornado Zone

Northern Research Station
USDA Forest Service

Micro-climate Changes in Springfield's Tornado Zone

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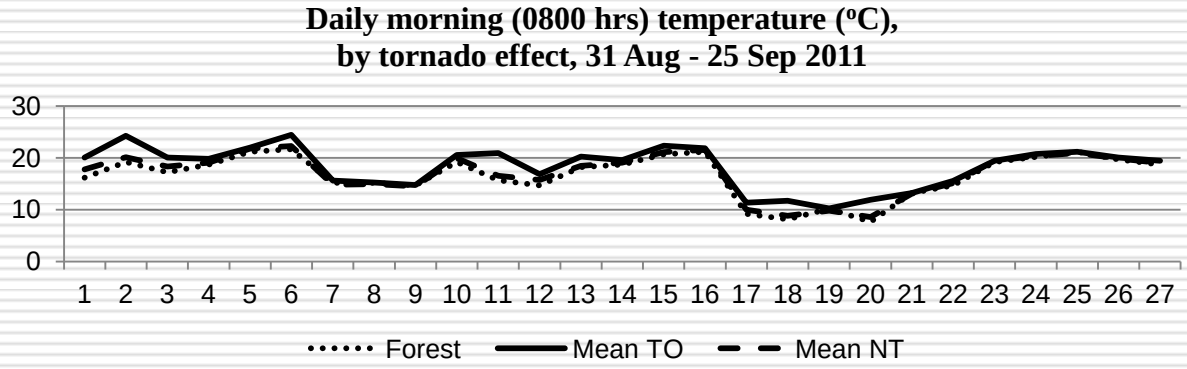
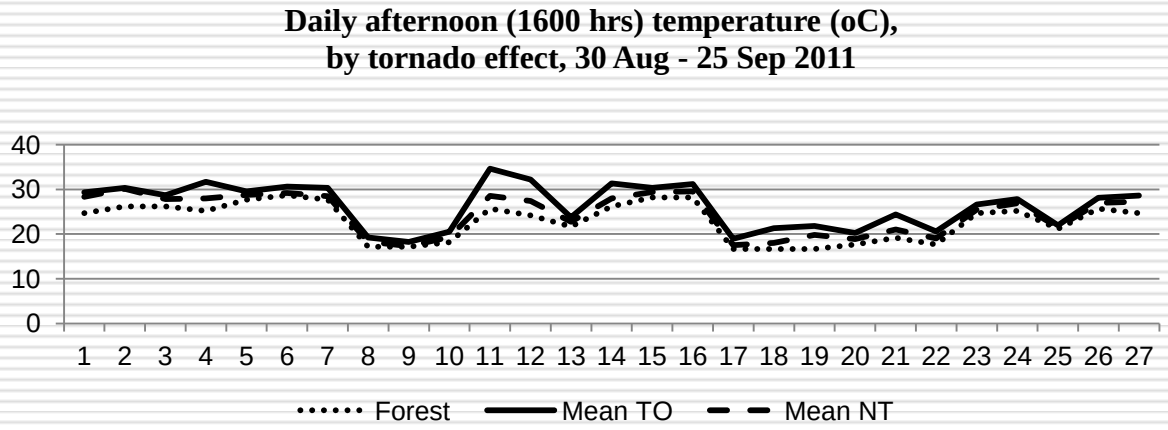
FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

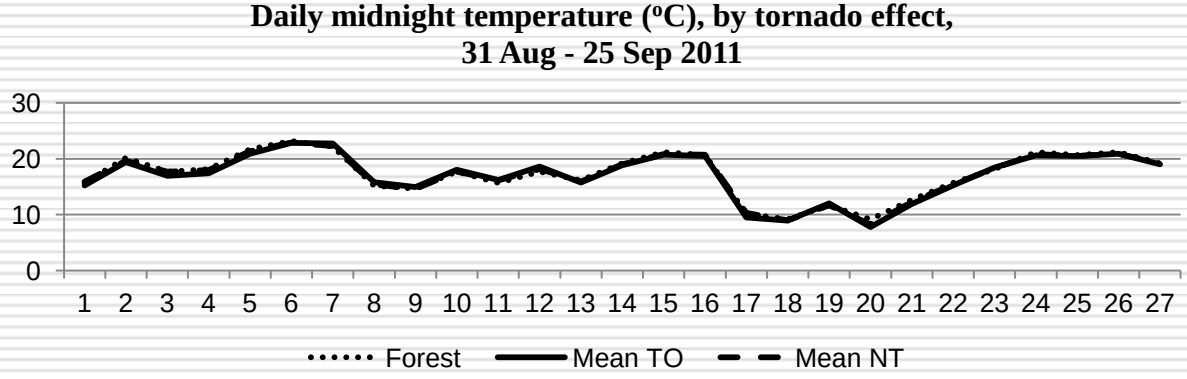
Micro-climate Changes in Springfield's Tornado Zone

	Tornado	Non-tornado	Forest
% canopy cover	0.8	44.2	99.7
Morning (0800 hrs)			
Temperature	18.2	17	16.6
%RH	95.4	96	99.4
Afternoon (1600 hrs)			
Temperature	26.4	24.6	22.9
%RH	64.3	67.1	80
Midnight			
Temperature	17	17.1	17
%RH	97.2	95.2	97.6

Figure 2. Daily street-side temperatures (ºC) by time of day, East Forest Park, Springfield, MA, 30 Aug – 26 Sep 2011.







Urban Forest Strike Team

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Assessing Storm Damage in Urbanized Landscapes: Preparation, Response & Recovery

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