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

David Bloniarz, USDA Forest Service

Northern Research Station
USDA Forest Service

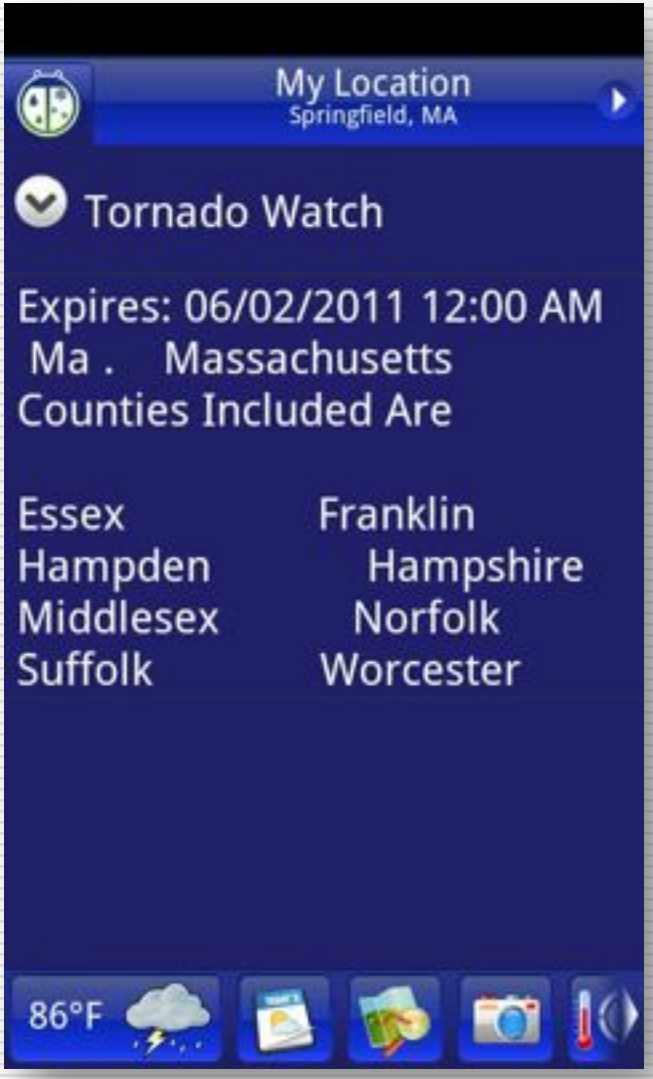
Why Prepare?

Tornados

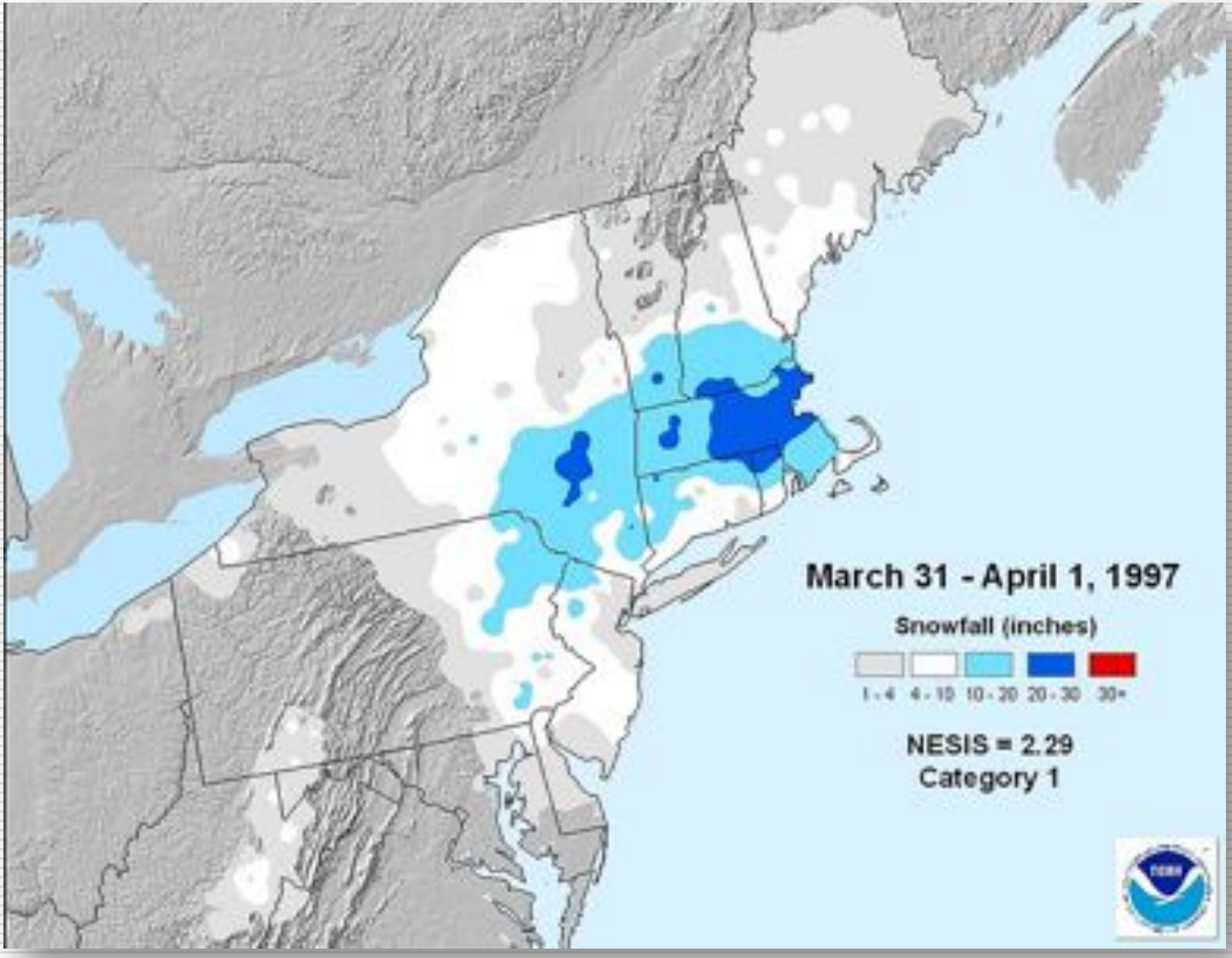
Thunderstorms & Wind

Snow

Any Time, Any Place….

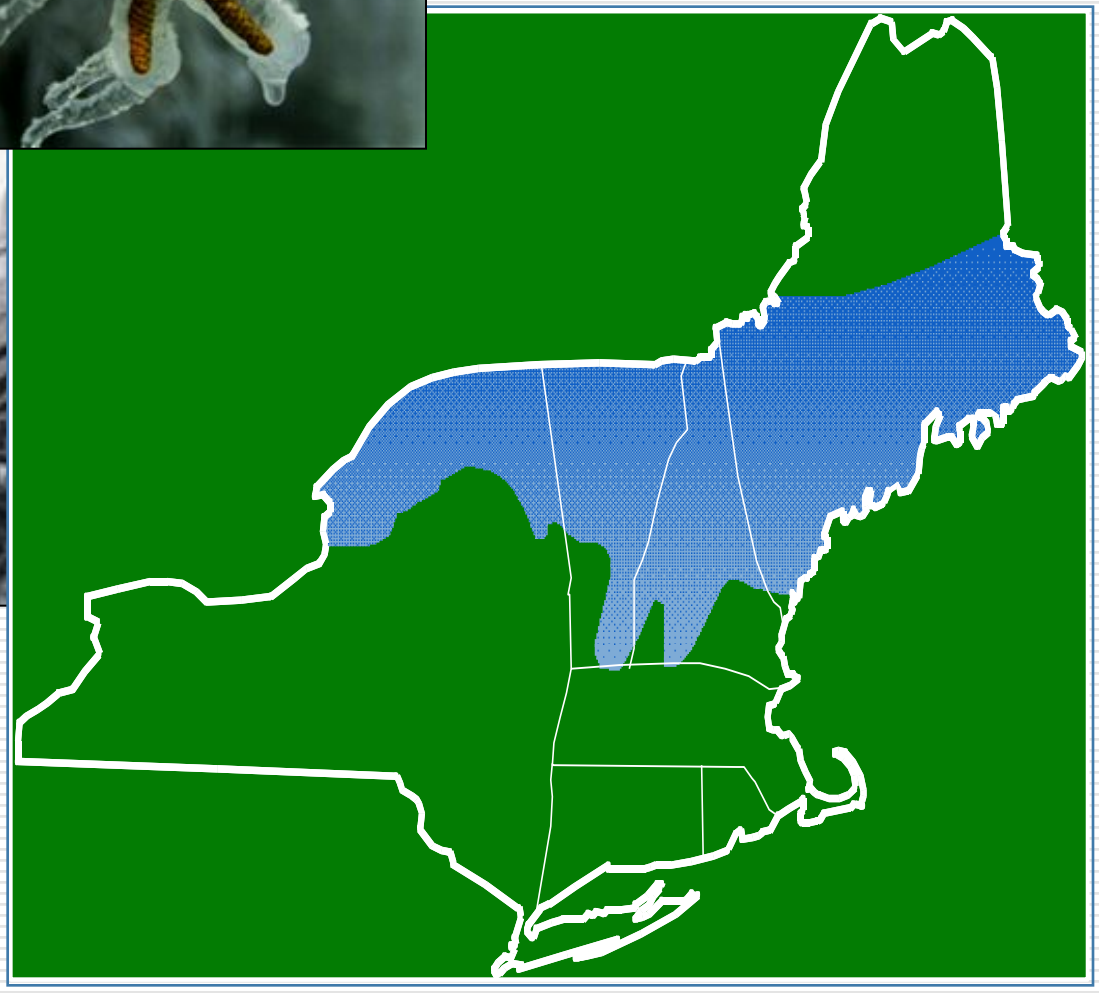


1997 April Fool's Day Blizzard



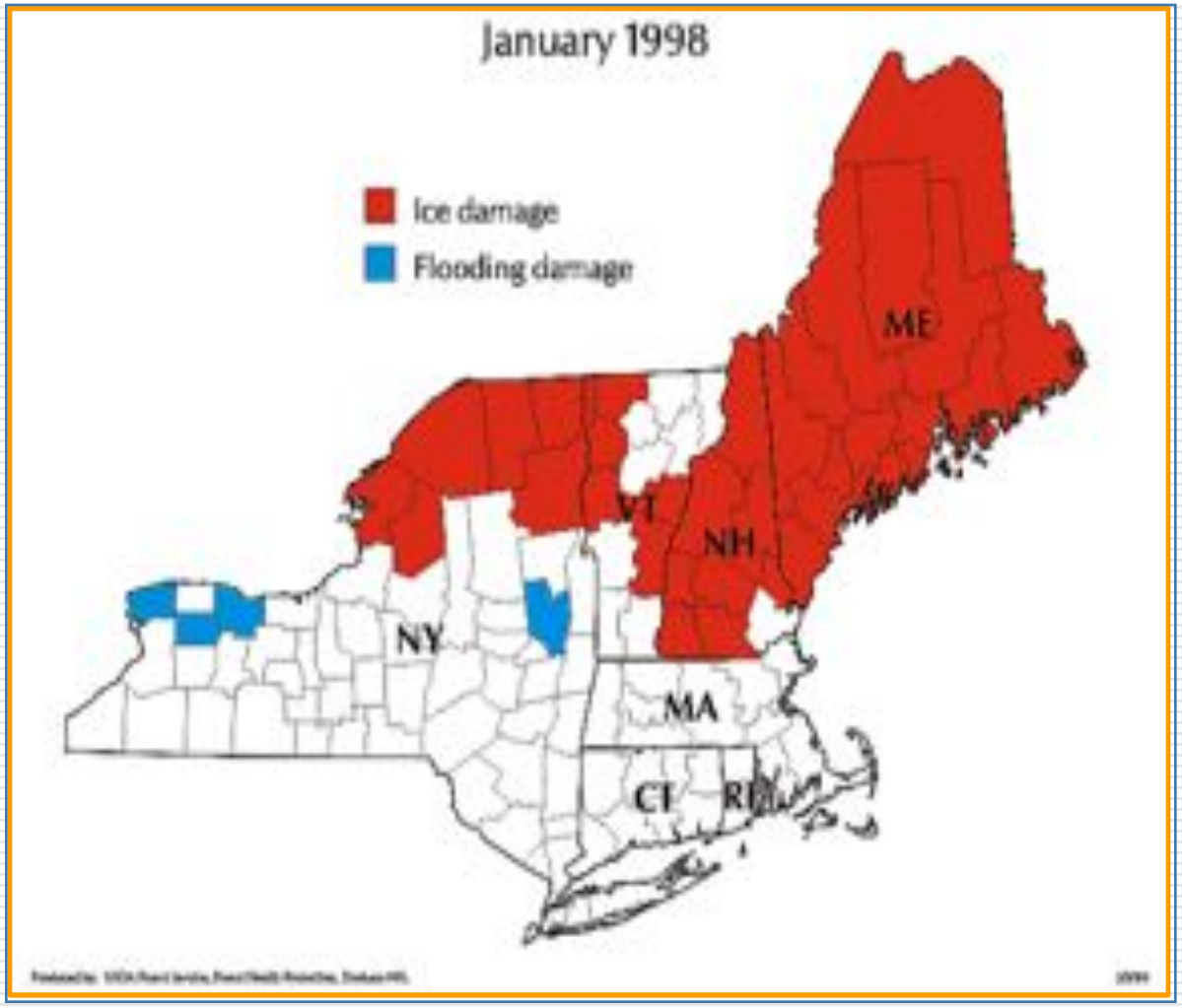
1997 April Fool's Day Blizzard

- 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

23 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

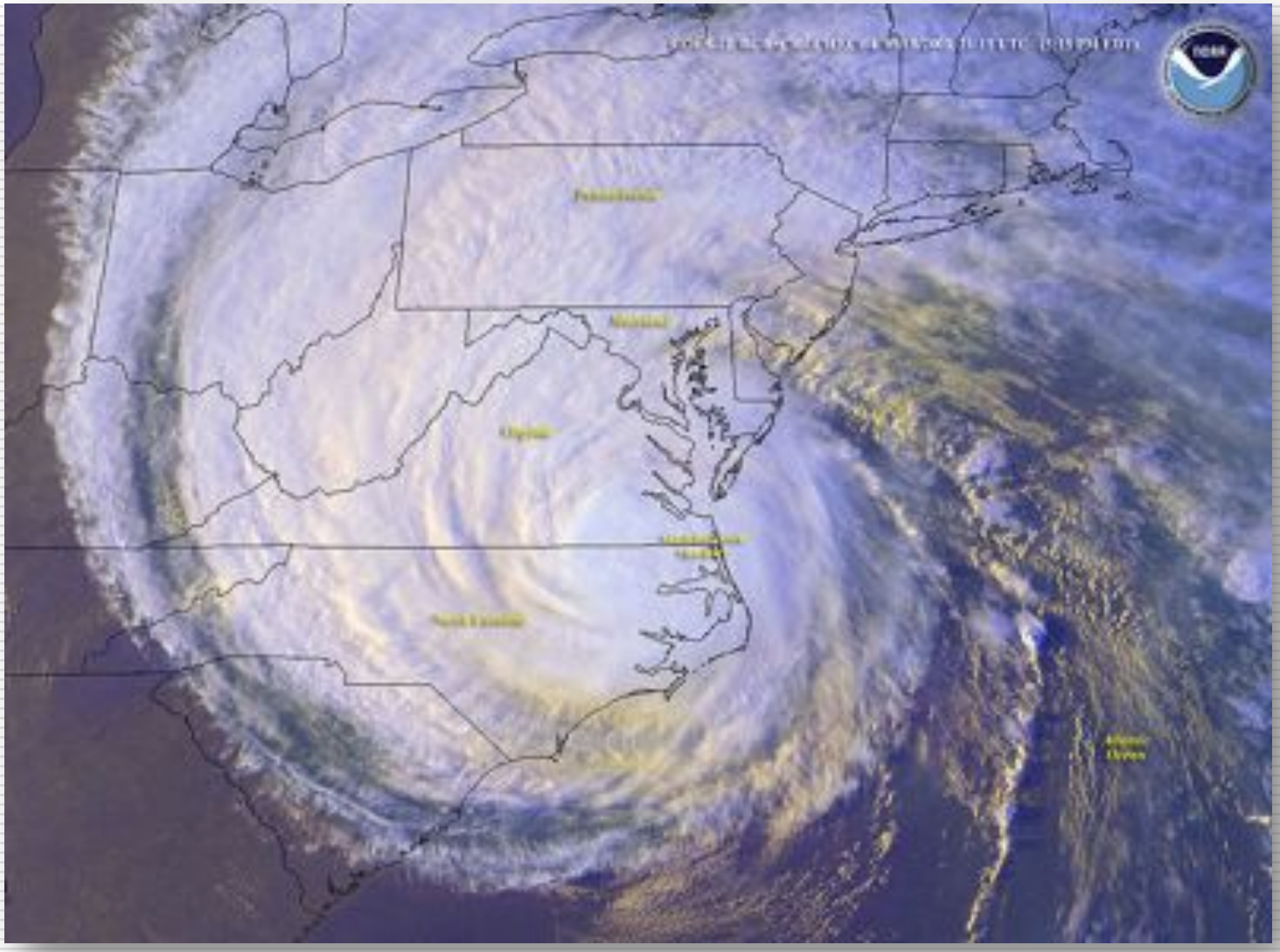
From downed lines to water, problems Isabel left behind

THE OUTER BANKS

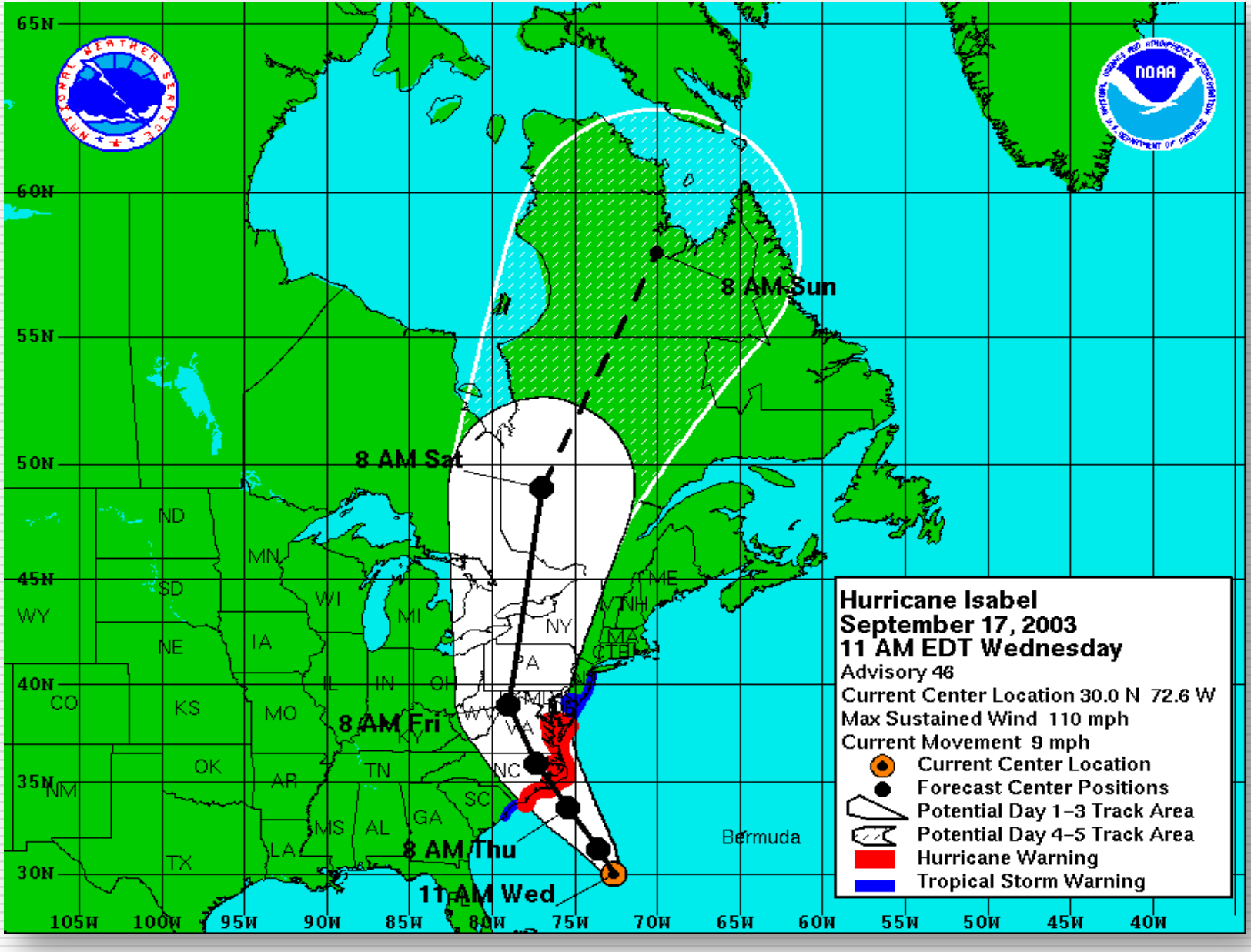
Hatteras Village isolated after hurricane cuts island in half

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

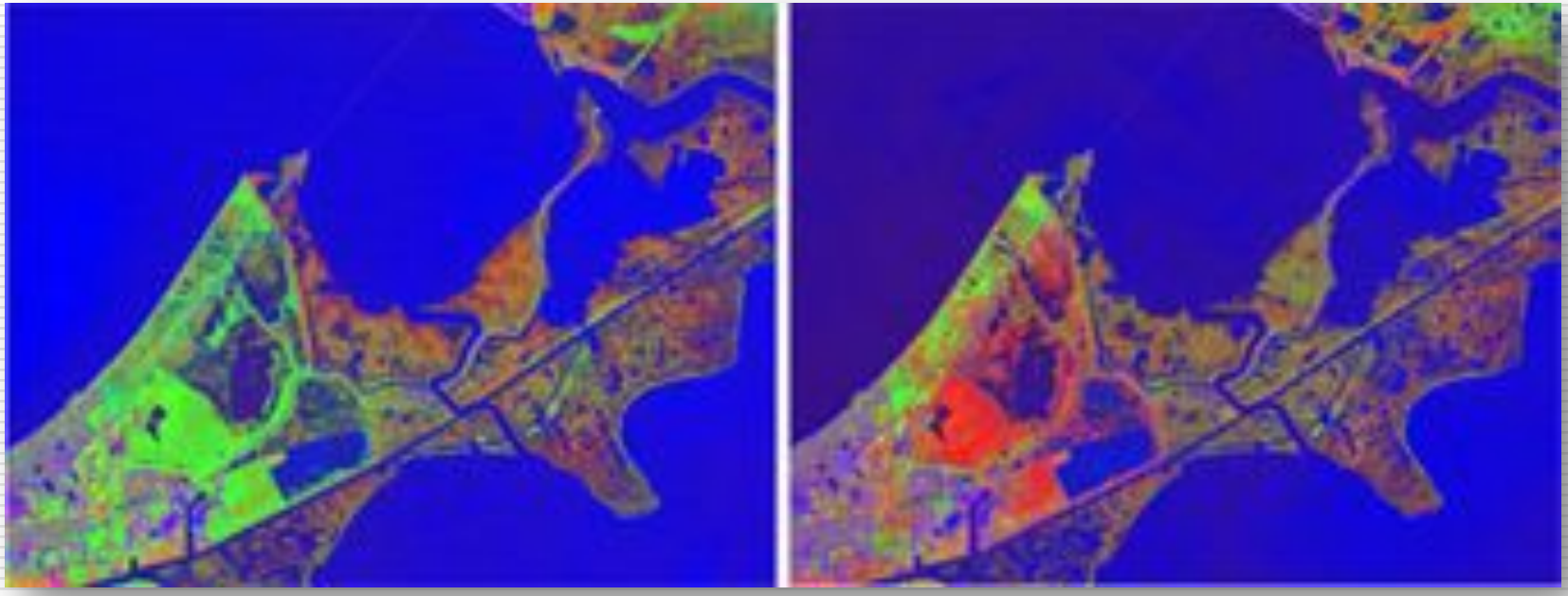
Katrina: Beyond the Trees

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

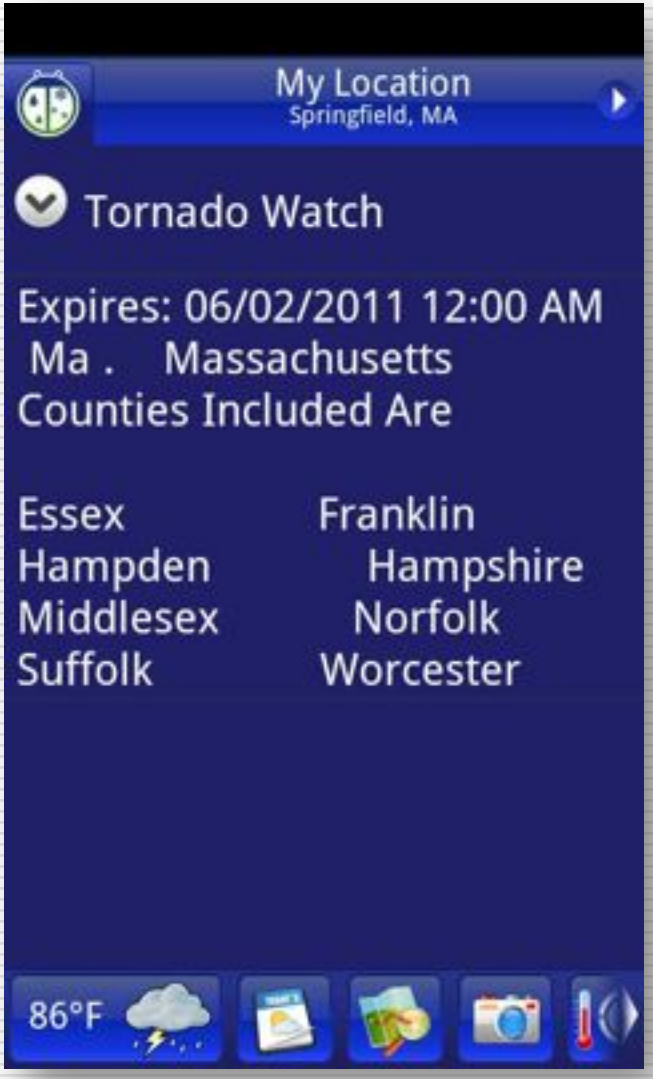
Katrina: Tree Loss



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

Western/Central Massachusetts
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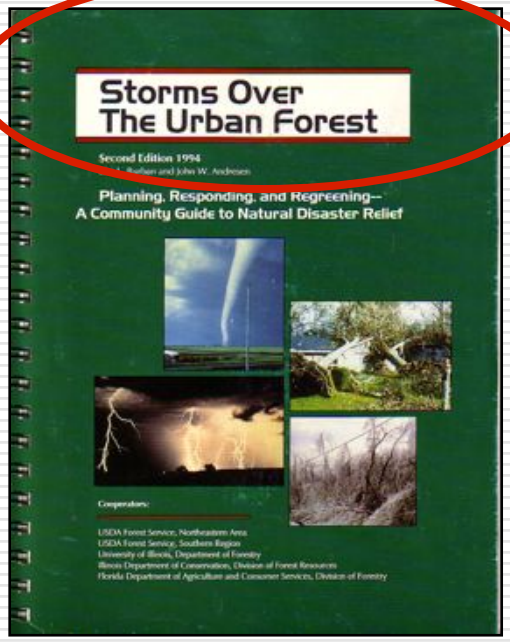
On the ground response and action

On the ground response and action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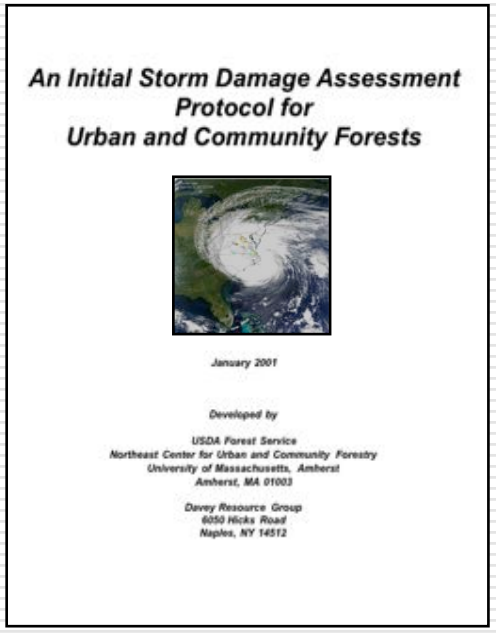
Tree Emergency Plan Worksheet
1. Early Warning System/Weather Forecasting Service
Staff Lead:
2. Local Emergency Manager
3. Public Relations Coordinator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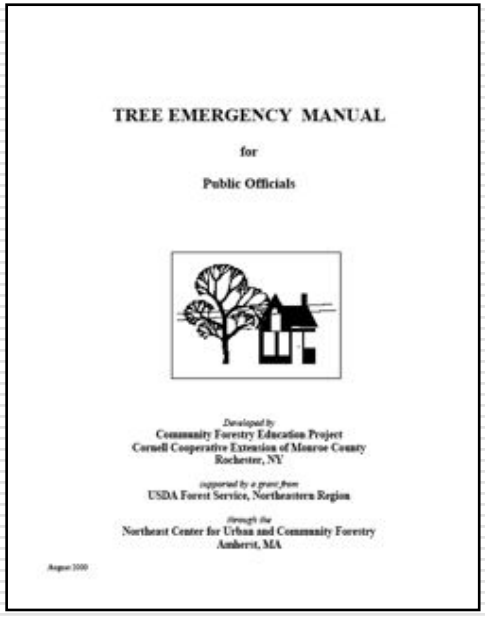
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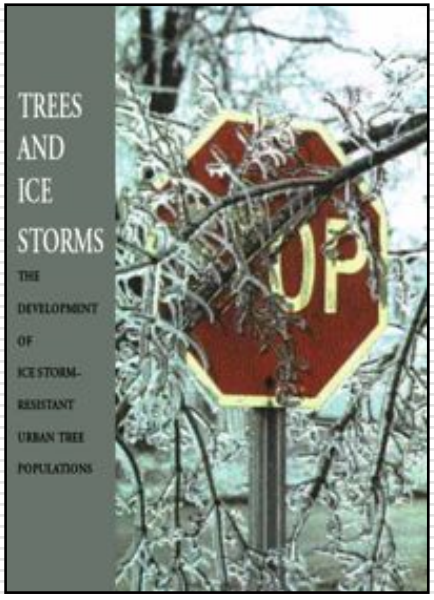
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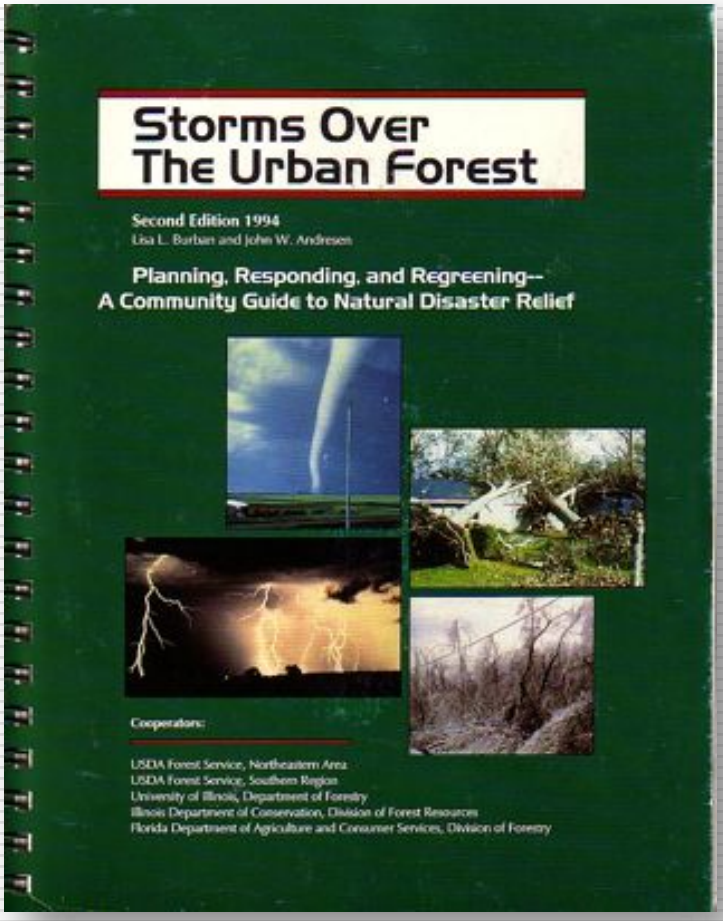
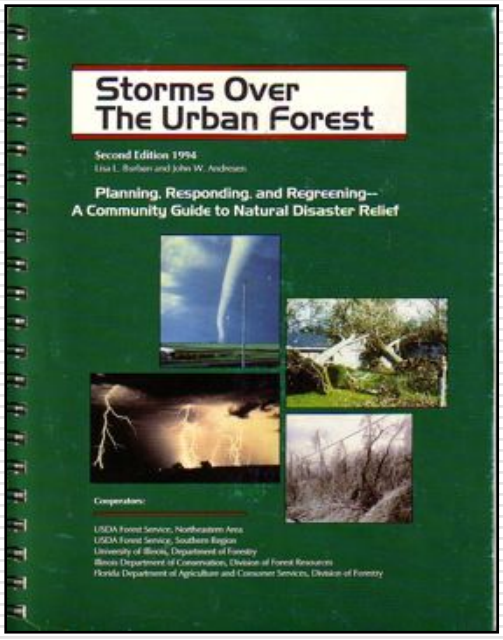


http://www.na.fs.fed.us/urban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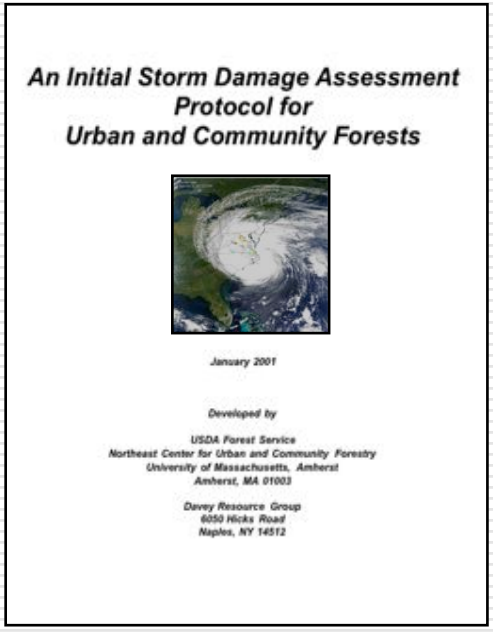
Staff Lead:
Contact Name:
Address:
Phone:
Mobile:
FAX:
Email:
Web Site:
Description of services provided:
2. Local Emergency Manager
Name:
Phone:
Mobile:
Role(s):
3. Public Relations Coordinator
Name:
Phone:
Mobile:
Alternate(s):
Name:
Phone:
Mobile:
Name:
Phone:
Mobile: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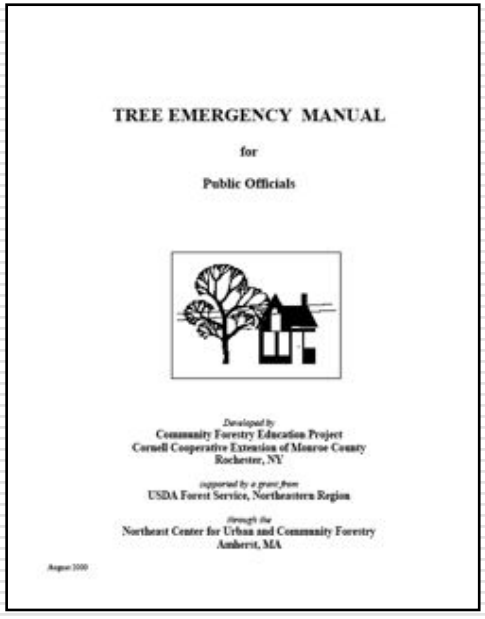
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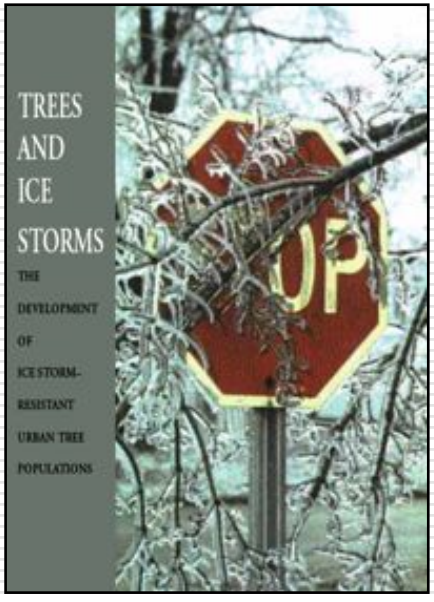
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Tree Emergency Plan Worksheet

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 at least three hours of lead time before most tree damaging weather strikes.

Staff Lead: _____

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

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: _____

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

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

Tree Emergency Plan Worksheet

6. Emergency Call Out Procedure

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 aren't always encouraged. 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 regarding tree debris collection. Determine if your city has adequate equipment and staff available to accomplish this often enormous task. If 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: _____

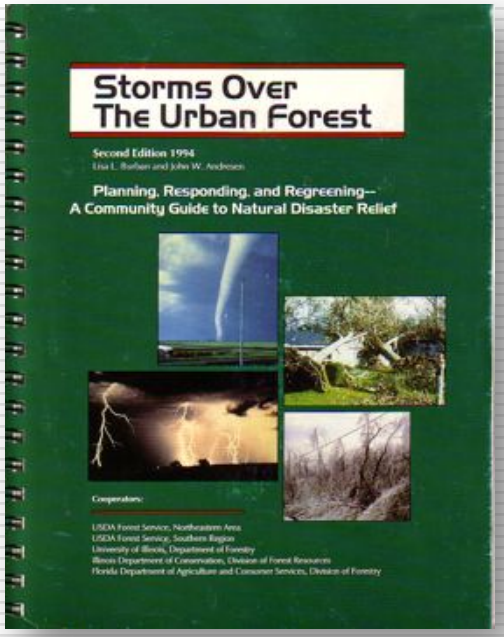
Minor Storm Policy:

Major Storm Policy:

Listing of available tree care companies:

8

http://www.na.fs.fed.us/urban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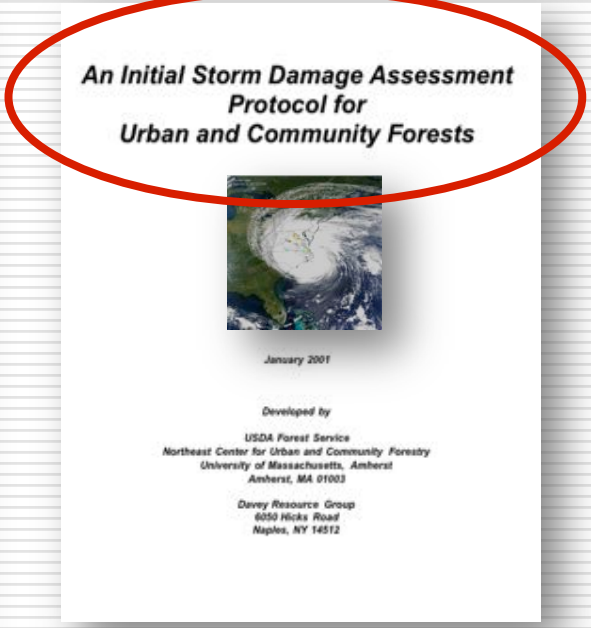
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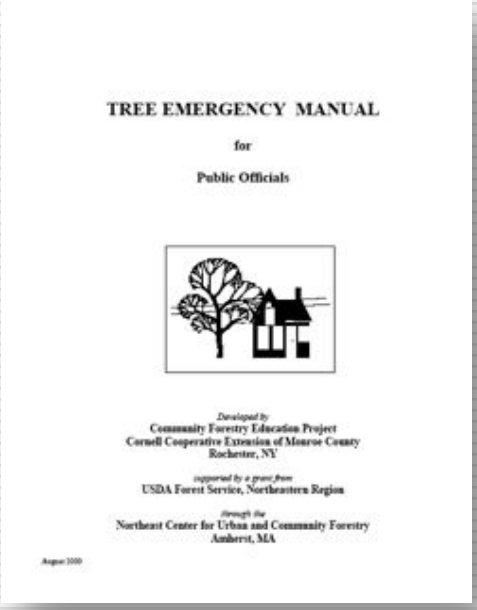
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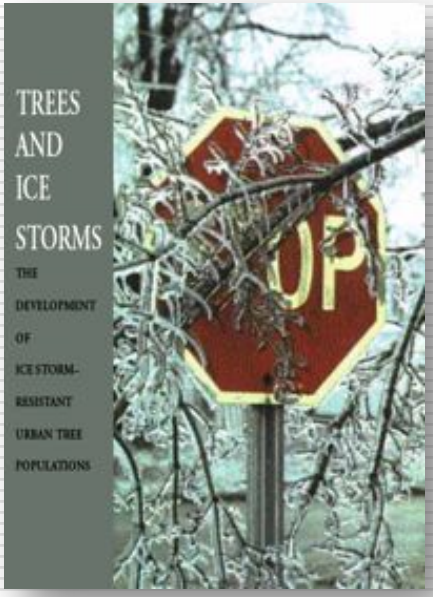
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Estimating Storm Damage Costs

What is i-Tree?

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

v. 3.0 programs

Public-Private Partnership

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

DAVEY

The National Arbor Day Foundation®

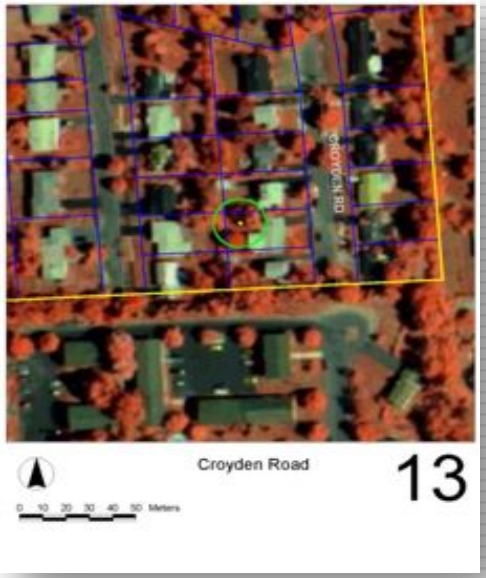
SOCIETY OF MUNICIPAL ARBORISTS
Trees ARE the City

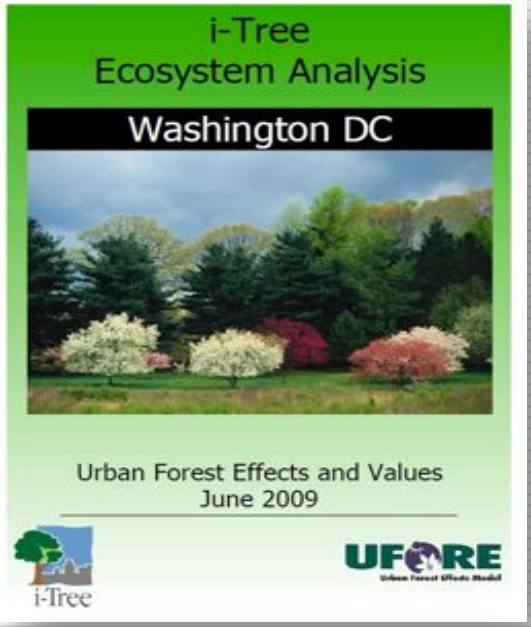
ISA
International Society of Arboriculture®

Casey Trees
WASHINGTON DC

Goals

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





i-Tree Version 4.0

- 5 New or Enhanced Tools

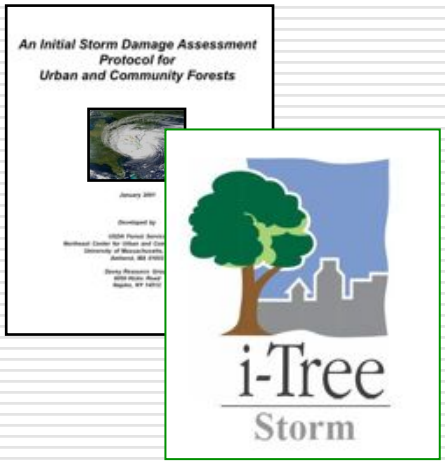
How Does Storm Work?

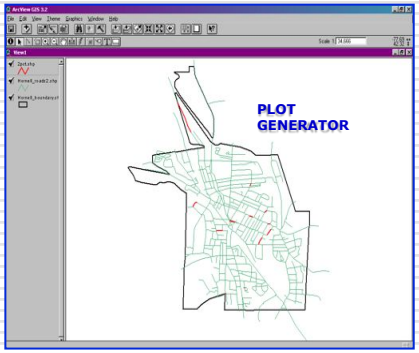
- Context of Use
- Sampling
- Data Collection
- PDA & Desktop Features

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

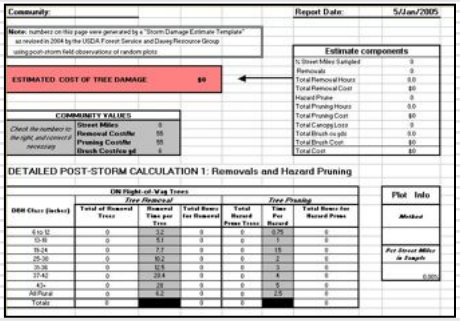
The SDAP Process



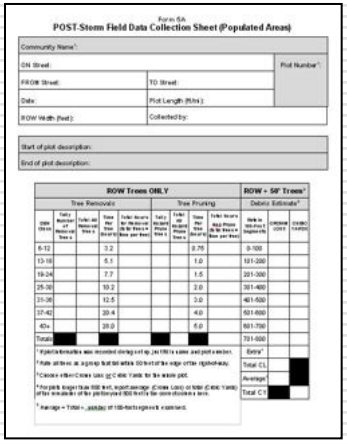


Random Plots

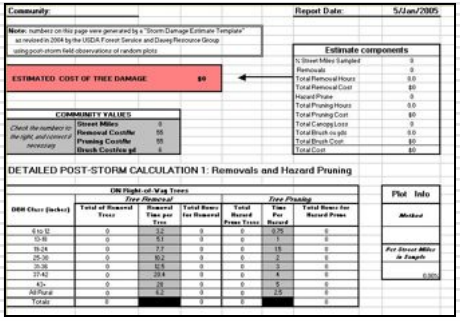
Pre-Storm Sample Survey



Estimating Engine



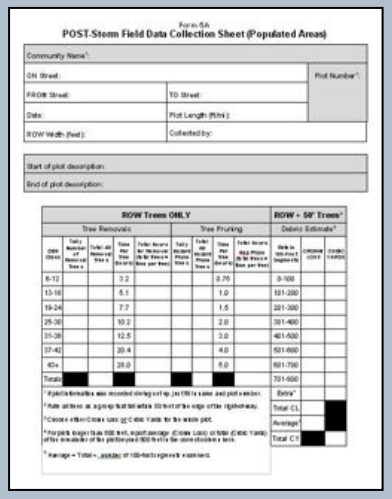
Post-Storm Survey



Final Damage Estimate

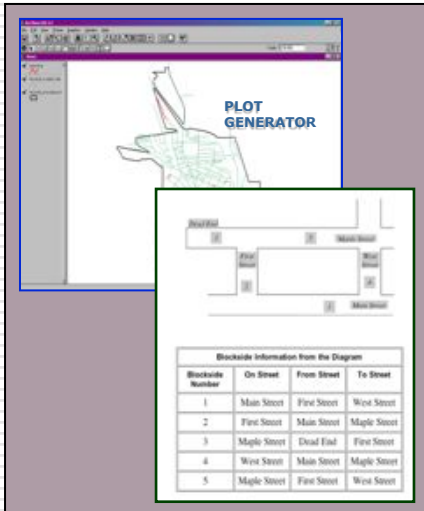
Components

i-Tree Storm

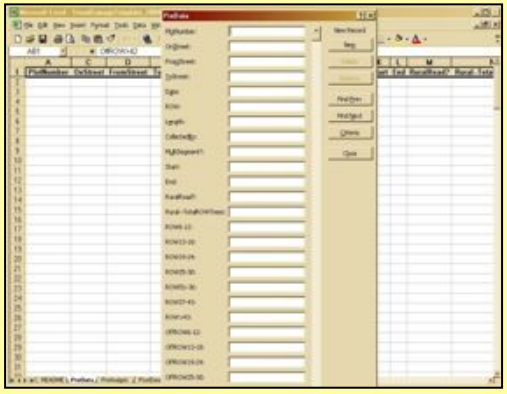


Data Collection- Paper

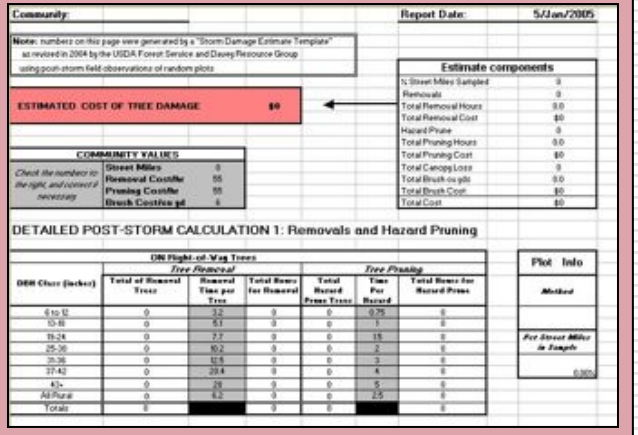
Data Collection- PDA



Sampling Tools



Data Storage & Processing

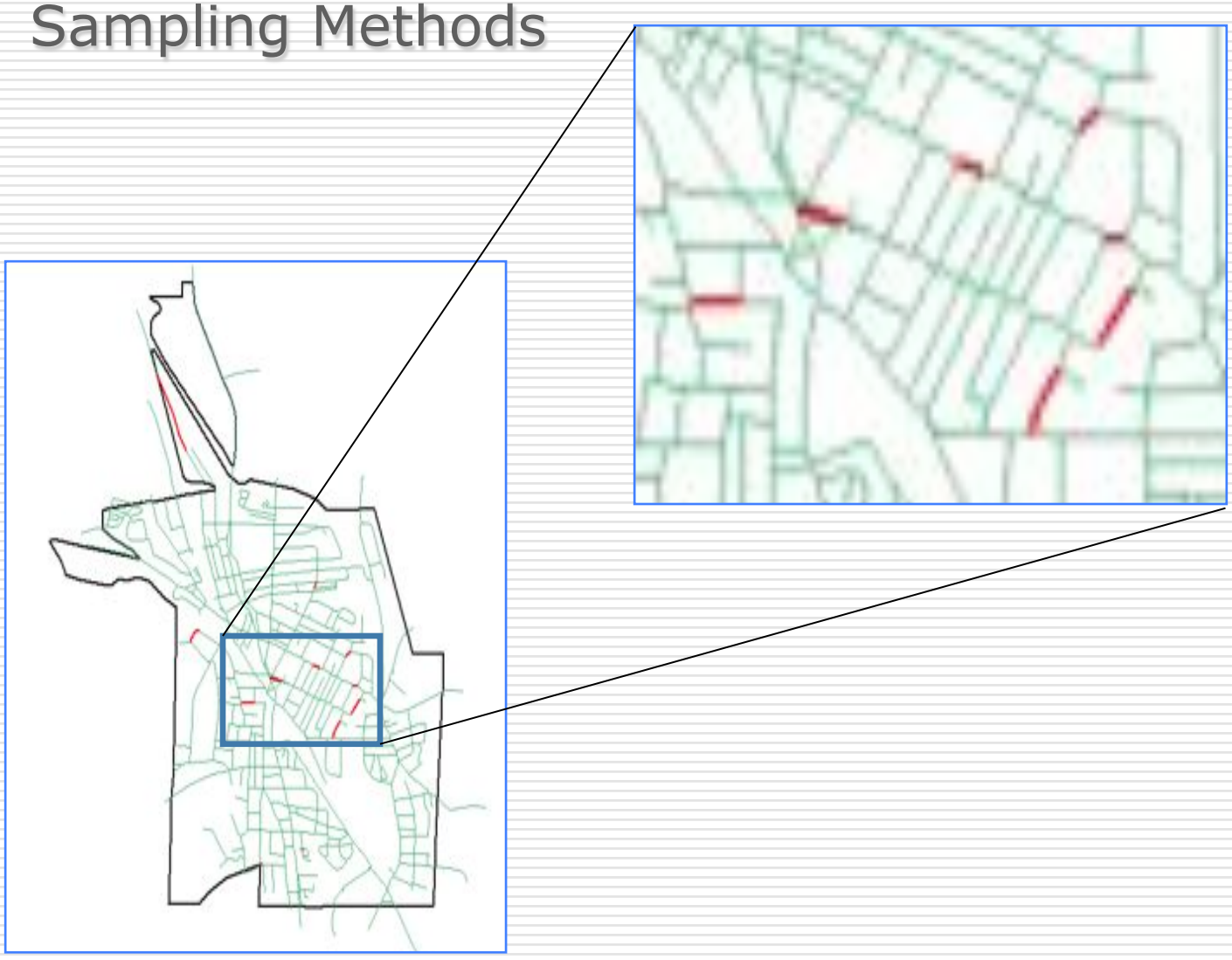


Reporting

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

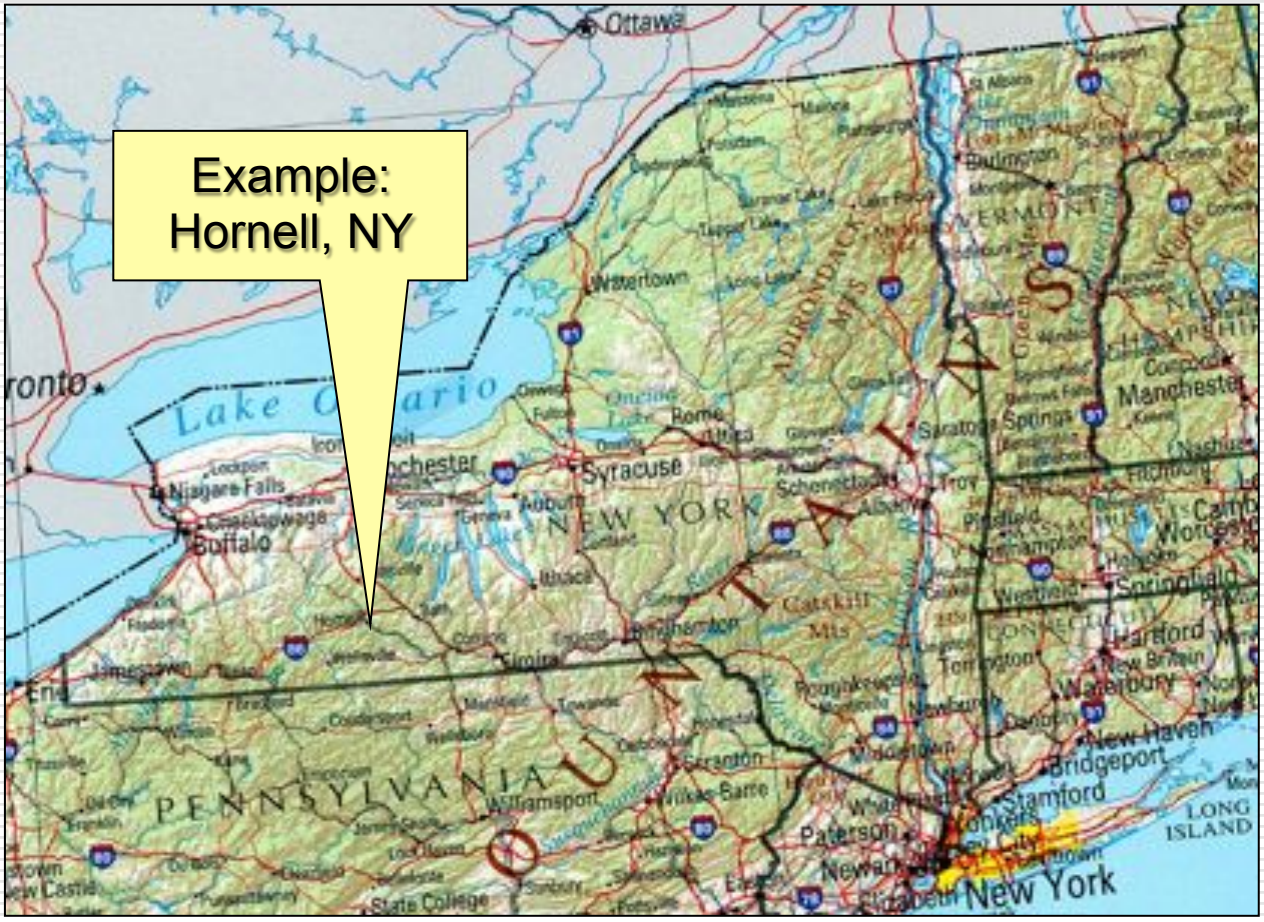
Sampling Methods

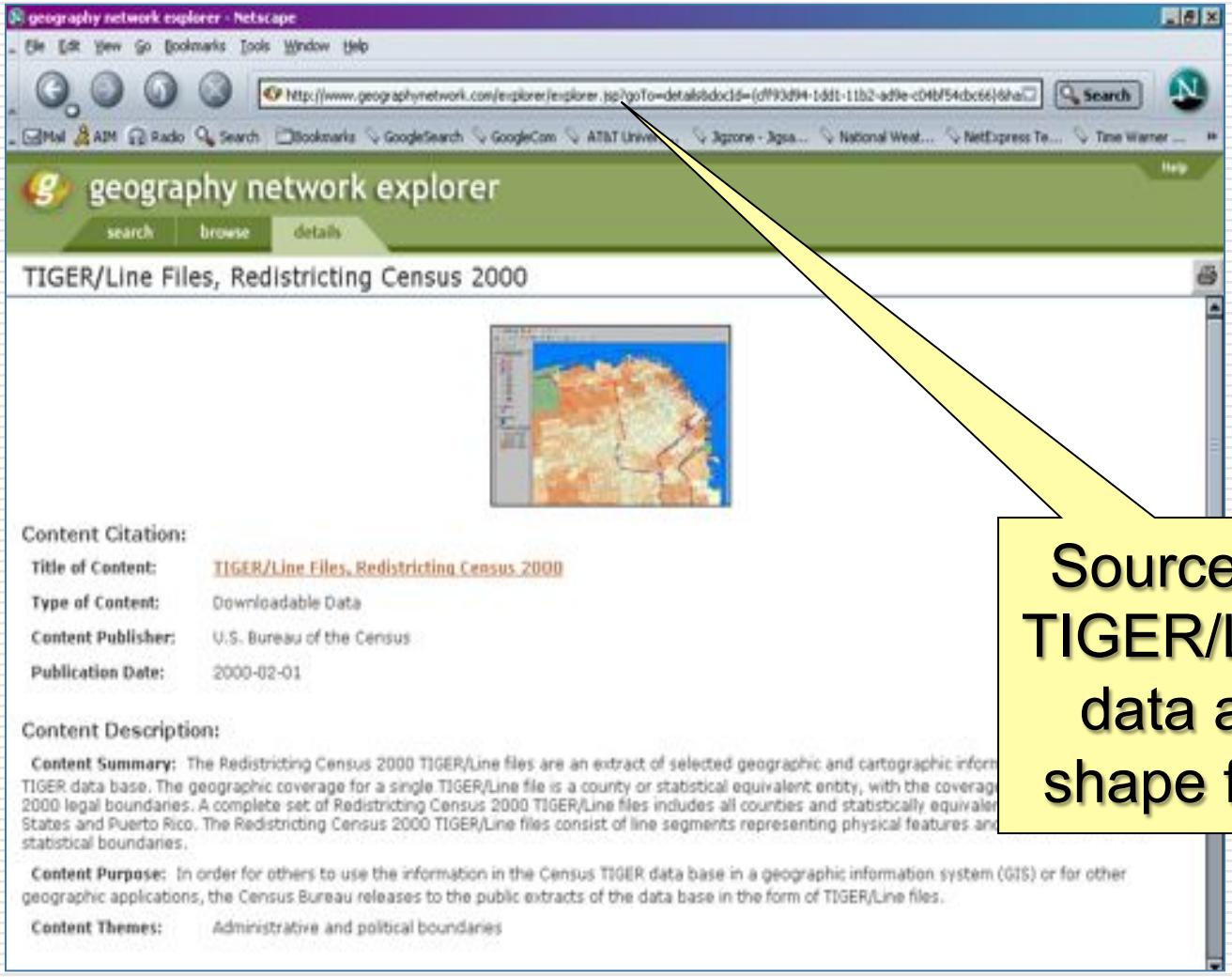


Manual Sampling Method

from the Diagram			
		From Street	To Street
		First Street	West Street
		Main Street	Maple Street
		Dead End	First Street
		Main Street	Maple Street
5	Maple Street	First Street	West Street

The Smarter Way

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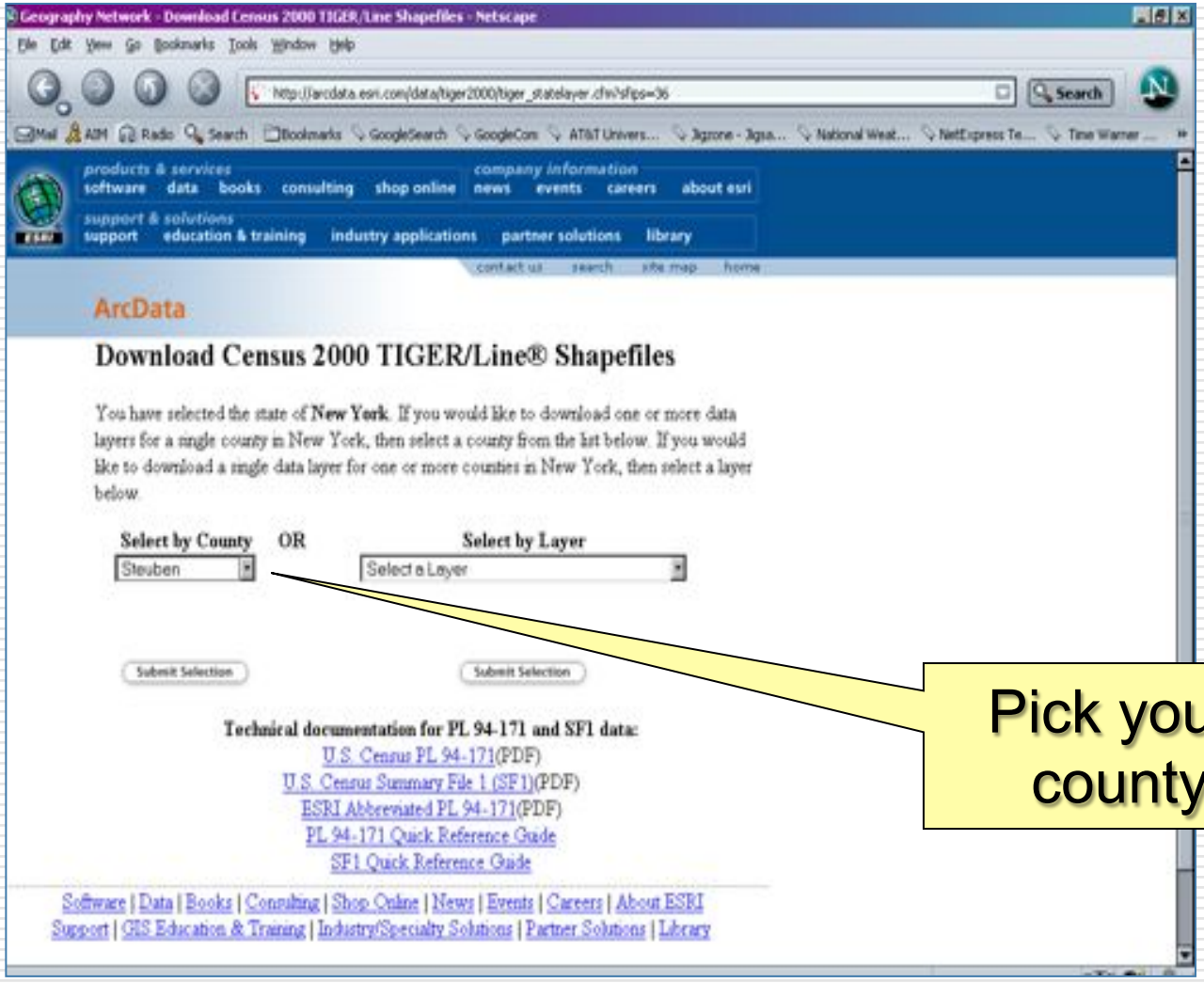
Type of Content: Downloadable Data
Content Publisher: U.S. Bureau of the Census
Publication Date: 2000-02-01
Content Description:
Content Summary: The Redistricting Census 2000 TIGER/Line files are an extract of selected geographic and cartographic
TIGER data base. The geographic coverage for a single TIGER/Line file is a county or statistical equivalent entity, with the
2000 legal boundaries. A complete set of Redistricting Census 2000 TIGER/Line files includes all counties and statistically
States and Puerto Rico. The Redistricting Census 2000 TIGER/Line files consist of line segments representing physical features
statistical boundaries.
Content Purpose: In order for others to use the information in the Census TIGER data base in a geographic information system (GIS) or for other
geographic applications, the Census Bureau releases to the public extracts of the data base in the form of TIGER/Line files.
Content Themes: Administrative and political boundaries
Source of TIGER/Line data as shape files


Geography Network - Download Census 2000 TIGER/Line Shapefiles - Netscape
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You have selected the state of New York. If you would like to download one or more data layers for a single county in New York, then select a county from the list below. If you would like to download a single data layer for one or more counties in New York, then select a layer below.
Select by County
OR
Select by Layer
Steuben
Select a Layer
Submit Selection
Submit Selection
Technical documentation for PL 94-171 and SF1 data:
U.S. Census PL 94-171(PDF)
U.S. Census Summary File 1 (SF1)(PDF)
ESRI Abbreviated PL 94-171(PDF)
PL 94-171 Quick Reference Guide
SF1 Quick Reference Guide
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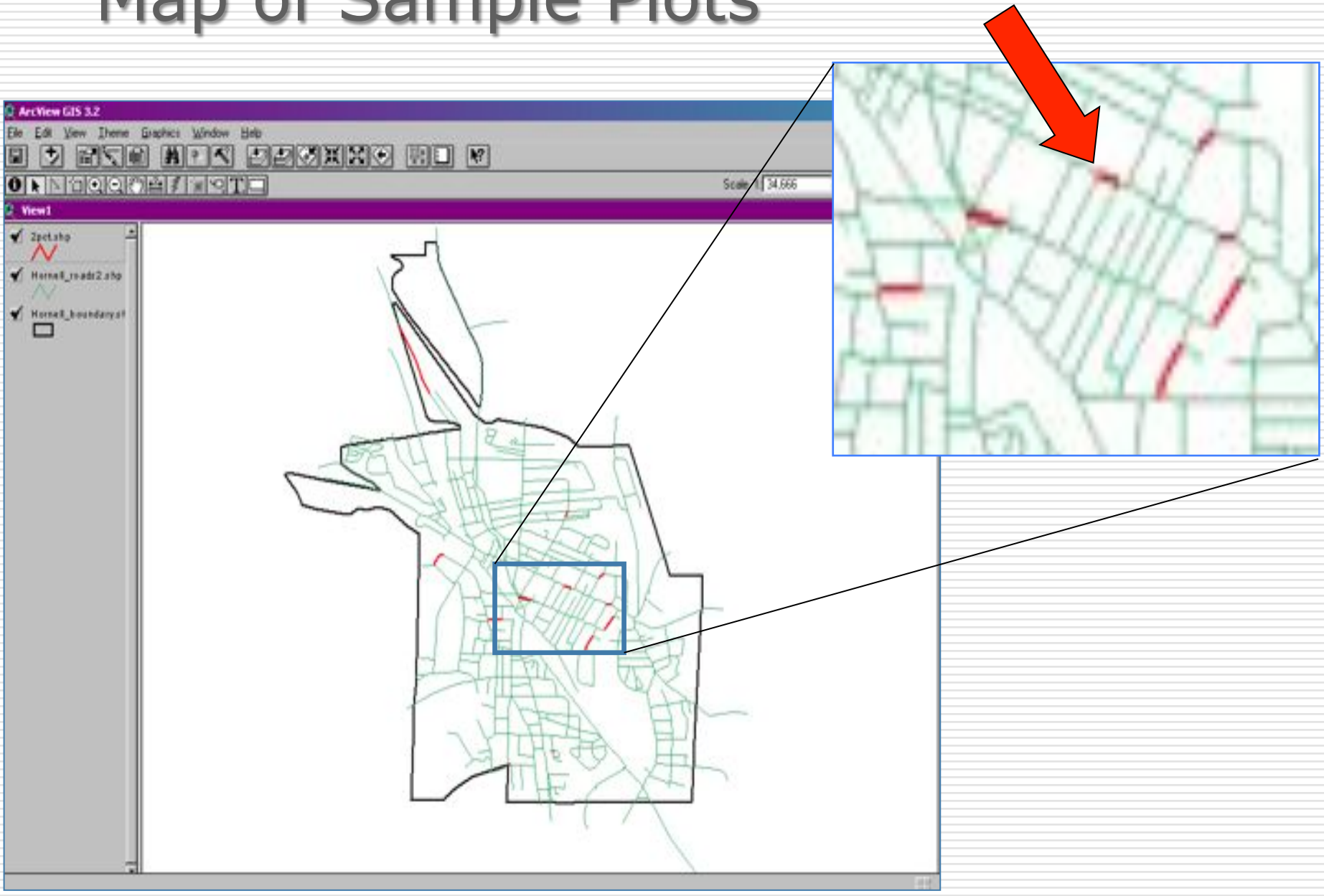
Map of Sample Plots

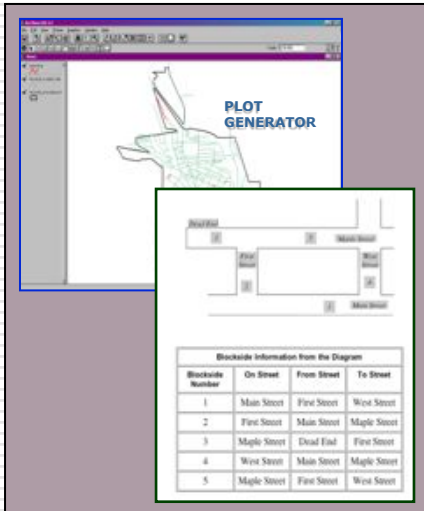


Components

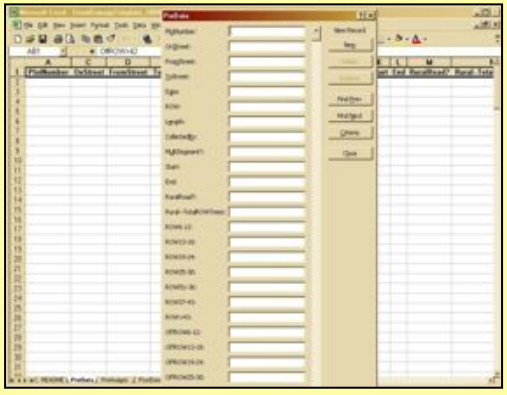
i-Tree Storm

Data Collection- Paper

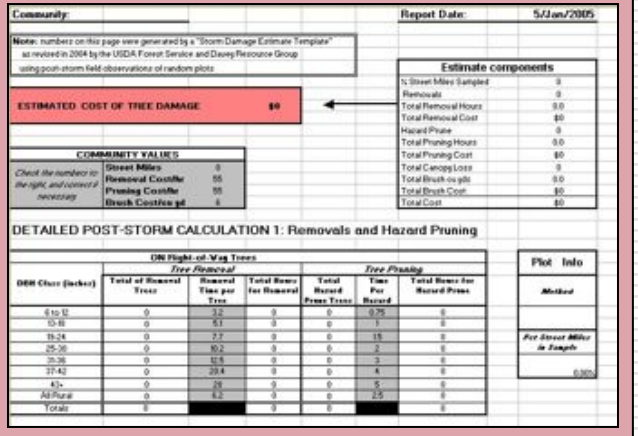
Data Collection- PDA



Sampling Tools

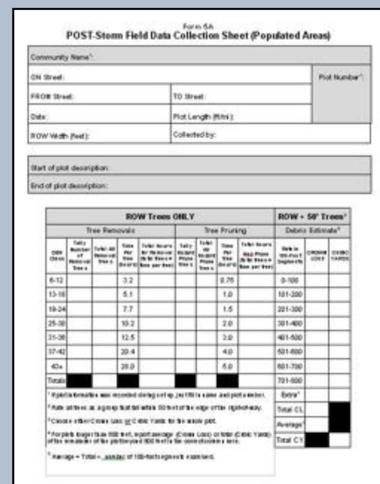


Data Storage & Processing



Reporting

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/m):	
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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		
40+			28.0				6.0		601-700		
Totals									701-800		
									Extra[4]		
									Total CL		
									Average[5]		
									Total CY		

[1] [illegible] 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 corresponding box.

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

Data Collection- Paper

Data Collection- PDA

Using i-Tree Storm

- Examples of Applied Use
- Success Stories
- Other Points

Data Collection

Form 6A

POST-Storm Field Data Collection Sheet (Populated Areas)

Community Name[1]:		
ON Street:		Plot Number[2]:
FROM Street:	TO Street:	
Date:	Plot Length (Rdm):	
ROW Width (feet):	Collected by:	

Start of plot description:
End of plot description:

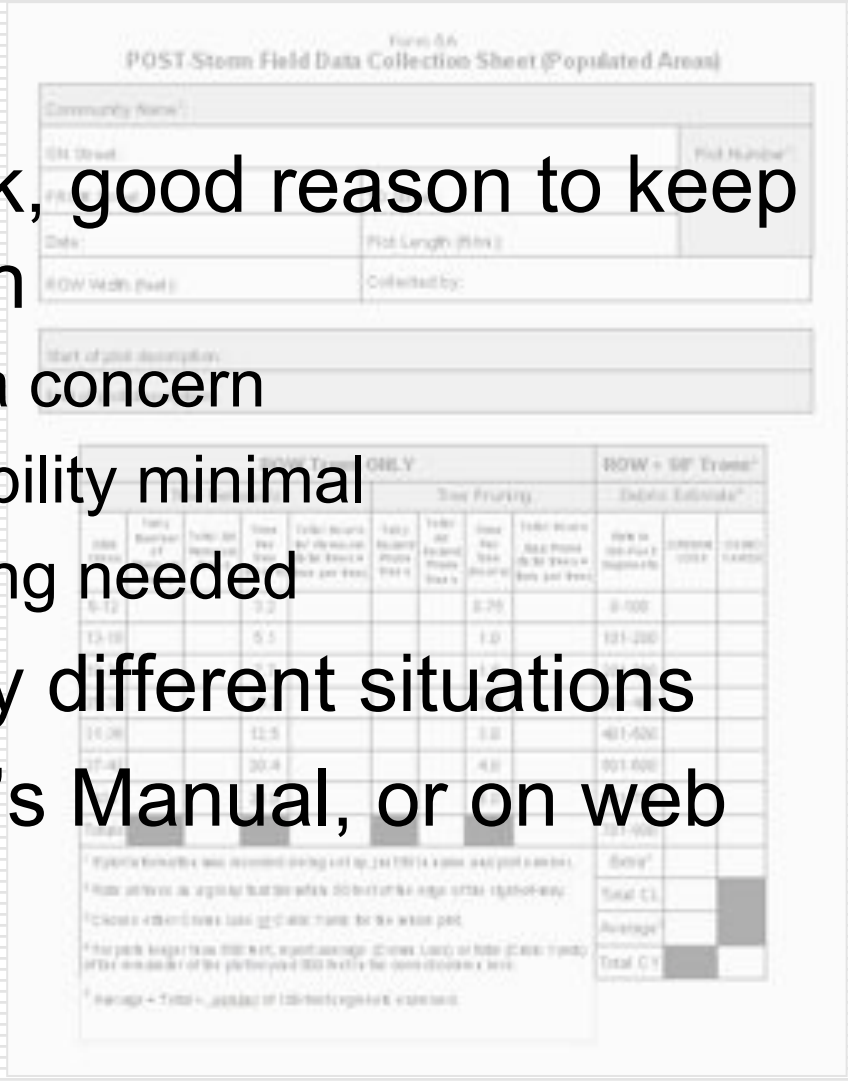
ROW Trees ONLY									ROW + 50' Trees[3]		
Tree Removals					Tree Pruning				Debris Estimate[4]		
DBH Class	Tally Number of Removed Trees	Total All Removed Trees	Time Per Tree (hr or min)	Total Hours for the Removal (By All Trees in Class per Crew)	Tally Number Pruned Trees	Total All Pruned Trees	Time Per Tree (hr or min)	Total Hours for Pruning (By All Trees in Class per Crew)	Mark in 100-Foot Segments	CHROMA COST	CHROMA HARDS
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		
42+			28.0				6.0		601-700		
Totals									701-800		
[1] Plot information was recorded during set up, just fill in name and plot number.									Extra[5]		
[2] Plots will have an approximate buffer width of the edge of the right-of-way.									Total CL		
[3] Choose either Crown Loss or Chroma Hards for the whole plot.									Average[5]		
[4] For plots longer than 800 feet, report average (Crown Loss) or total (Chroma Hards) after evaluation of the plot beyond 800 feet is the same/close/more or less.									Total CH		
[5] Average = Total ÷ number of 100-foot segments examined.											

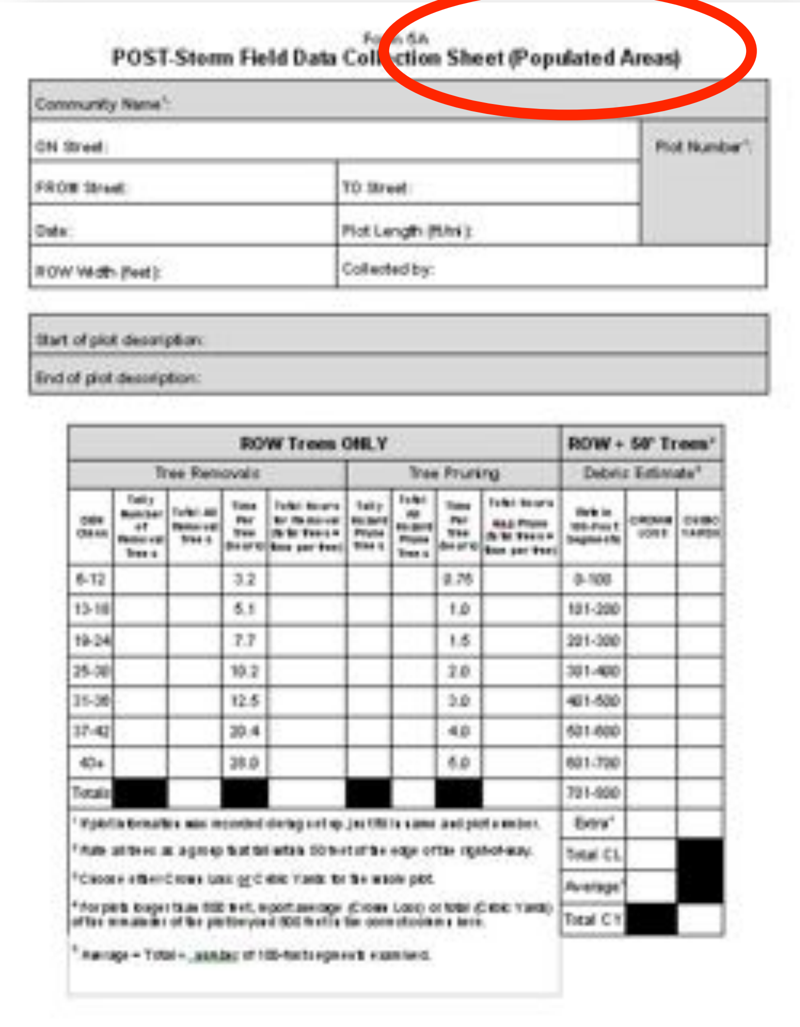
Overview: Pre-storm setup

- 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 6A
POST-Storm Field Data Collection Sheet (Populated Areas)



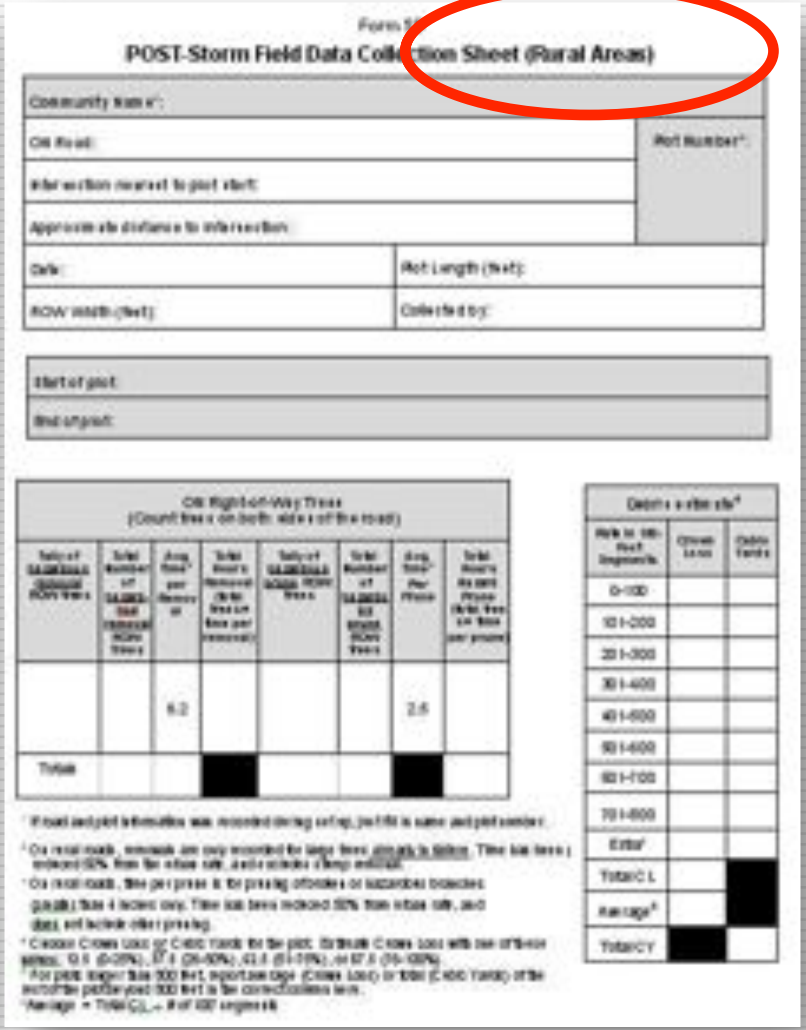
Form 5A

POST-Storm Field Data Collection Sheet (Populated Areas)

Community Name[1]:	
ON Street:	Plot Number[1]:
FROM Street:	TO Street:
Date:	Plot Length (ft/m):
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	Tally Hazard Prune Trees	Total All Hazard Prune Trees	Time Per Tree (hours)	Total Hours Hazard Prune	Plots 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+			30.0				6.0		601-700		
Totals									701-800		
									Extra[4]		
									Total CL		
									Average[5]		
									Total CY		



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 per Removal	Total Hours Removal	Tally of hazardous prune ROW trees	Total Number of hazardous prune ROW trees	Avg. Time Per Prune	Total Hours Hazard Prune
		6.2				2.5	
Totals							

Debris estimate[4]		
Plots 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] Road and plot information was recorded during set up, just fill in name and plot number.

Form 5C

POST-Storm Field Data Collection Sheet (Non-linear Maintained Areas)

Community/Facility Name*:	Plot number*:
Survey Area Location:	
Collected by:	Date:

Indicate reference points to relocate the plot center		
Ref point 1:	Compass Bearing 1:	Distance 1:
Ref point 2:	Compass Bearing 2:	Distance 2:
Ref point 3:	Compass Bearing 3:	Distance 3:
Permanent plot center marker (Y/N)?	Marker type:	
Other:		

Maintained Trees								
Tree Removals					Tree Pruning			
DBH Class	Tally of trees for Removal	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 Hazard Prune (total trees × time per tree)
[illegible]-12			3.2				0.75	
13-18			5.1				1.0	
19-24			7.7				1.5	
25-30			10.2				2.0	
31-36			12.8				3.0	
37-42			20.4				4.0	
43+			25.0				5.0	
Totals								

FILL IN ONE: Crown Loss* ______ % OR Cubic Yards: ______

* If [illegible] plot information was recorded during pre-storm set up, just fill in same [illegible] plot number.

* 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%).

Form 5[illegible]

POST-Storm Field Data Collection Sheet (Non-linear Unmaintained Areas)

Community/Facility Name*:	Plot number*:
Survey Area Location:	
Collected by:	Date:

Indicate reference points to relocate the plot center		
Ref point 1:	Compass Bearing 1:	Distance 1:
Ref point 2:	Compass Bearing 2:	Distance 2:
Ref point 3:	Compass Bearing 3:	Distance 3:
Permanent plot center marker (Y/N)?	Marker type:	
Other:		

Unmaintained Trees							
Tally of Trees for Removal	Number of Trees for Removal	Avg. Time per Removal	Total Hours Removal (total trees × time per removal)	Tally of Trees for Hazard Prune	Number of Trees for Hazard Prune	Avg. Time Per Prune	Total Hours Hazard Prune (total trees × time per prune)
		6.2				2.5	
Totals							

FILL IN ONE: Crown Loss* ______ % OR Cubic Yards: ______

* If [illegible] plot information was recorded during pre-storm set up, just fill in same [illegible] plot number.

* Record only larger trees [illegible] with a tally mark, then put the total count in the [illegible] boxes.

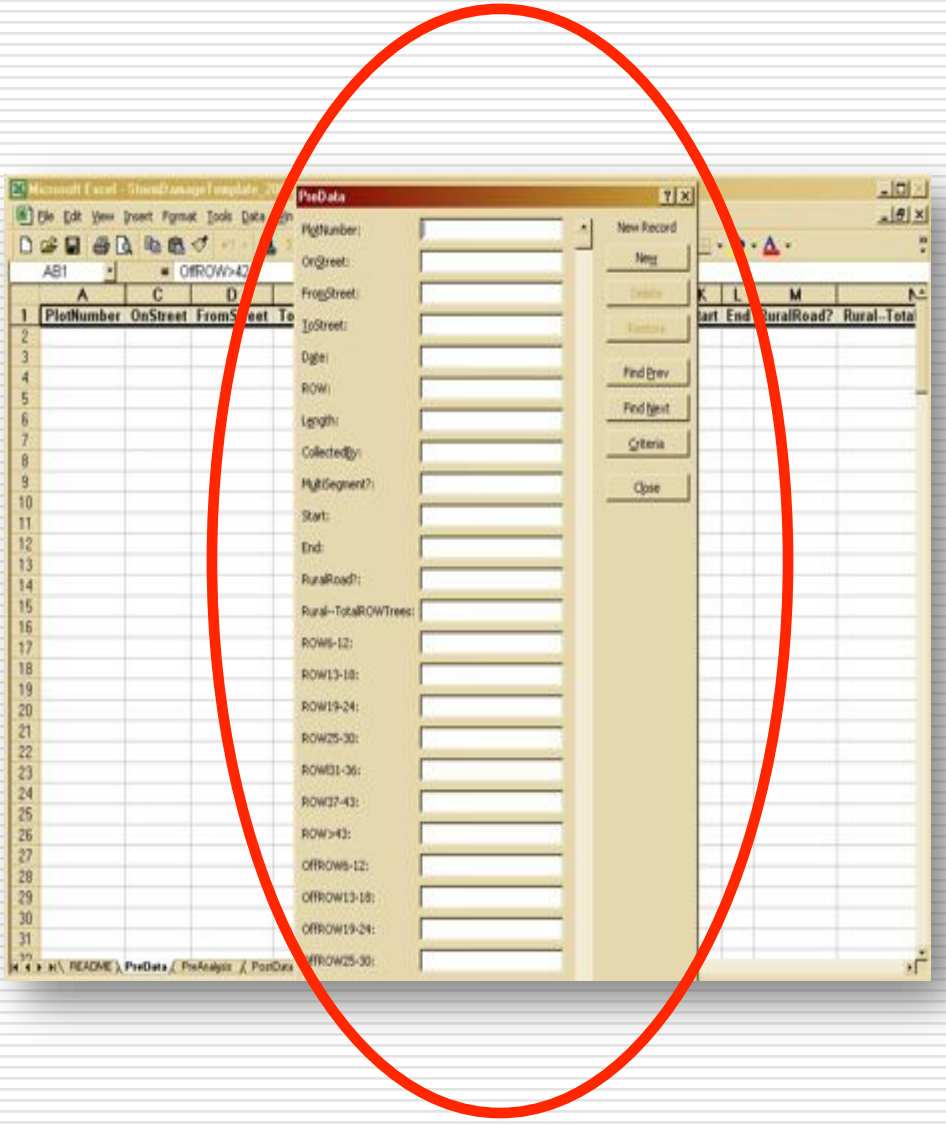
* Record hazard pruning for branches > 4" [illegible]

* 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%).

Data collection: data entry

- Paper forms only
- Easiest to use Excel's entry form
  - Highlight top row of headers
  - On menu, click

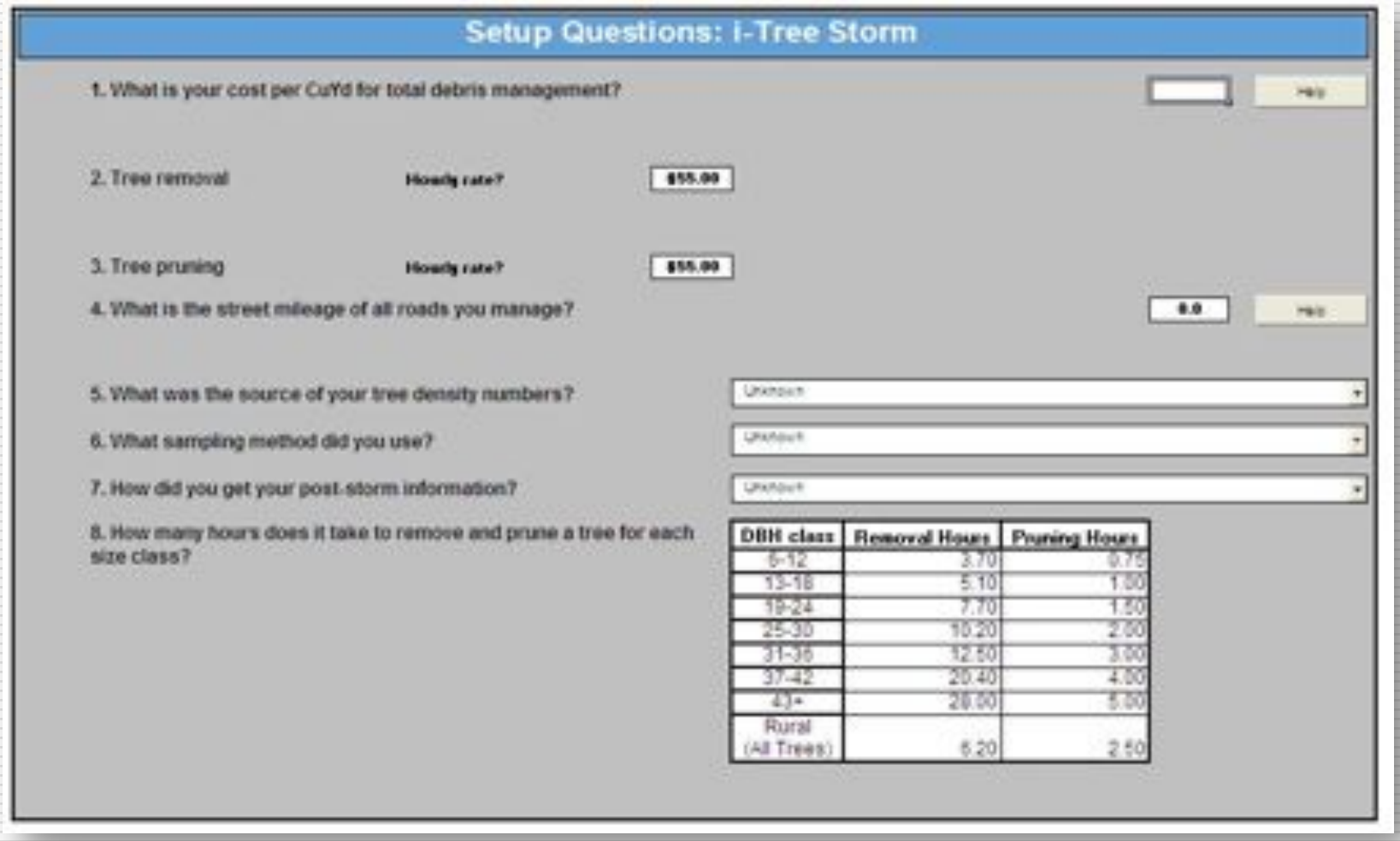
    Data → Form
- Can also just start typing at cell A1



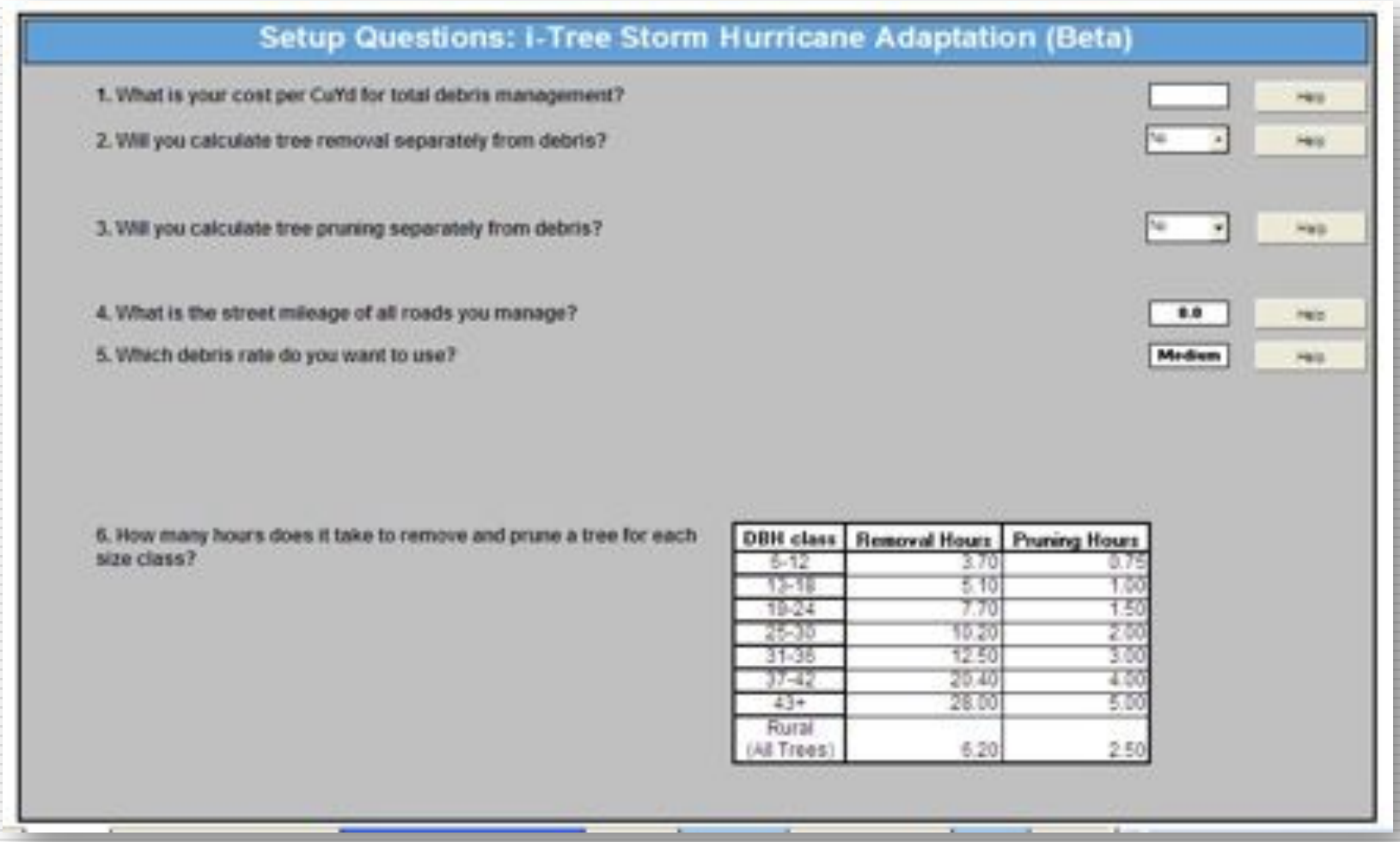
Data Collection: Desktop Interface

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

Data Collection: Desktop Interface



Data Collection: Desktop Interface



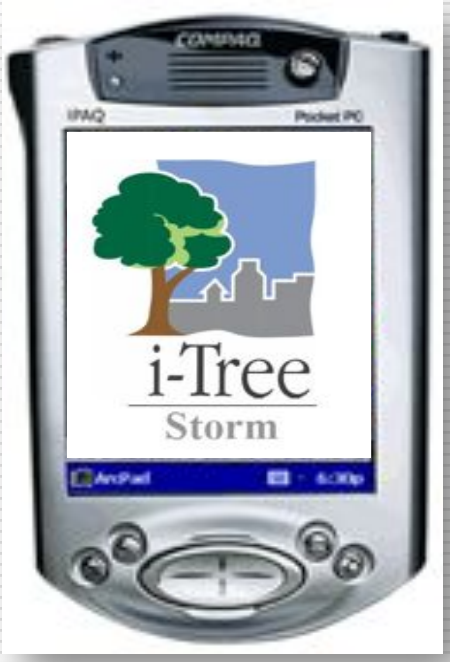
Setup Questions: i-Tree Storm Hurricane Adaptation (Beta)

1. What is your cost per CuYd for total debris management?
2. Will you calculate tree removal separately from debris?
3. Will you calculate tree pruning separately from debris?
4. What is the street mileage of all roads you manage? 0.0
5. Which debris rate do you want to use? Medium
6. How many hours does it take to remove and prune a tree for each size class?

DBH class	Removal Hours	Pruning Hours
6-12	3.70	0.75
13-18	5.10	1.00
19-24	7.70	1.50
25-30	10.20	2.00
31-36	12.50	3.00
37-42	20.40	4.00
43+	28.00	5.00
Rural (All Trees)	6.20	2.50

PDA Setup Interface

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



Overview: Post-storm work

- Revisit sample segments
  - Storm or Hurricane: choose estimation method
    - Indirect by average crown loss class
      - 0-25%, 26-50%, etc.
      - Loss category images available from FS
      - All trees within 50’ of ROW
    - Direct as CY of debris
  - Only trees within ROW
    - Hazard pruning by size class
    - Hazard removal by size class
- Enter data, report results

Overview: Validity

- Peer reviewed sampling protocols
- Also: storm type factor
  - Tested for ice storms
    - Low variance
    - 2% sample got within 5% of true value in field test
  - Not tested for wind storms
    - Larger variance
    - May affect required sample size
- Area of ongoing i-Tree research

Estimating Engine

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

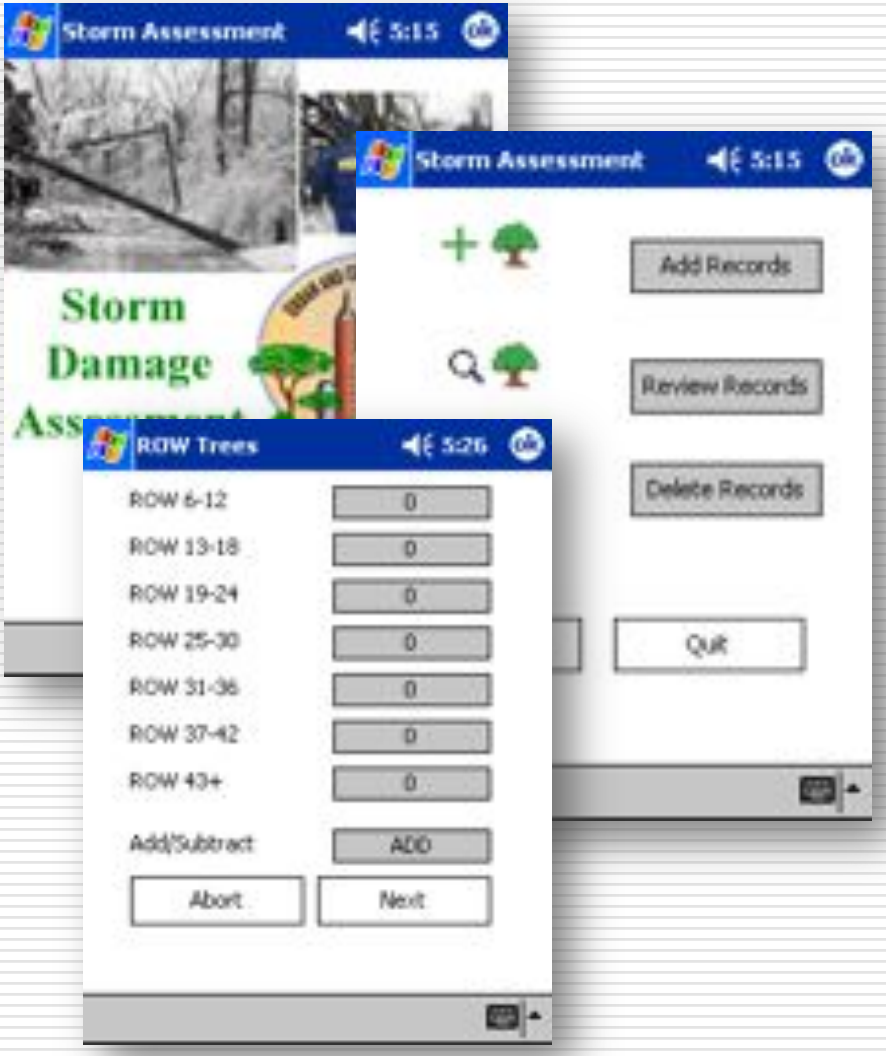
* SE of Total Debris cu yds is calculated only on direct CY estimates; crown loss estimates are ignored

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	±103.76	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

Data collection: PDA

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



Reference data (plots)

- TIGER
  - Can upload sample TIGER/Line data
  - Same process as described before
- Manual
  - Can do own sample from map
  - Must be random
- For both, recommended
  - 2% of blocksides
  - 30 minimum (maximum?)

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

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Total Debris Cost	$4,084,273	$407,325

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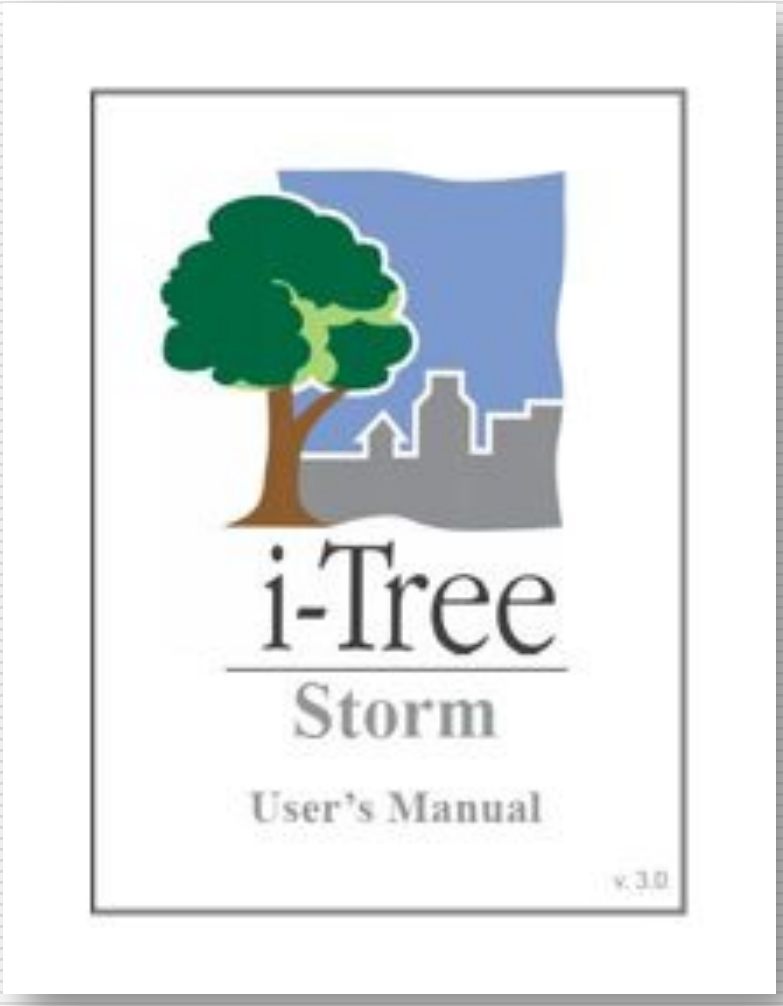
DETAILED POST-STORM CALCULATION: Hazard Removal and Pruning

	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	±103.76	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

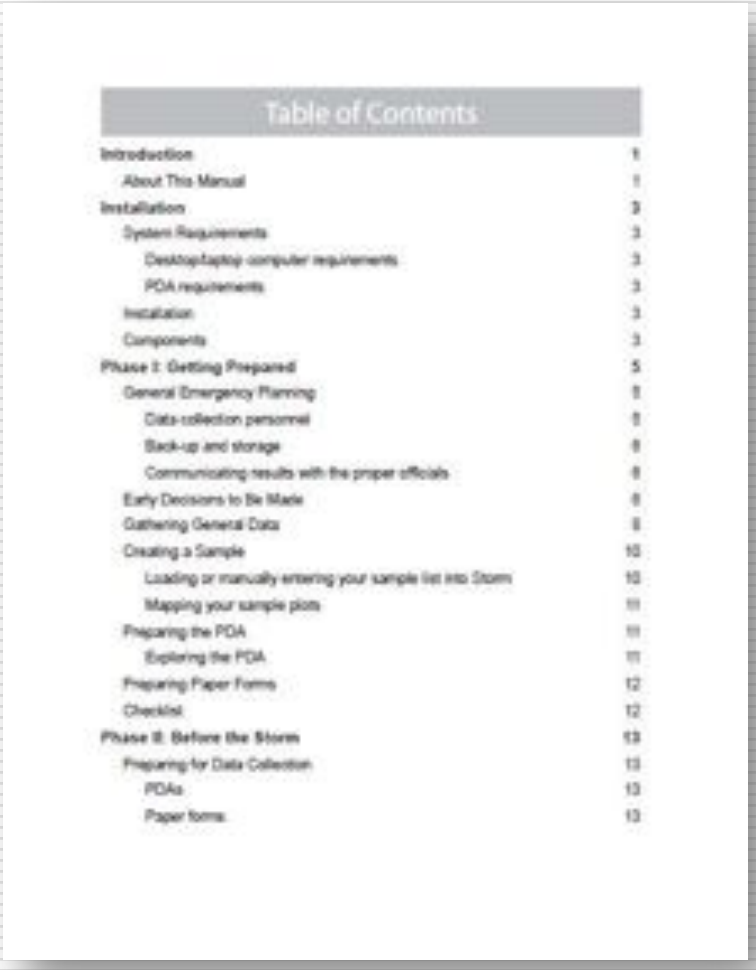


Table of Contents

Storm User's Manual

Storm User's Manual

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?

Hurricane Adaptation users must also decide: Will you separate estimates for tree removal and tree pruning from estimates of debris removal?

The data collection protocol differs slightly depending on whether you will bid out emergency work in a lump sum for debris (including pruning and removal), or instead break it up by handling the emergency tree pruning and/or removal with a different contract.

Hurricane Considerations

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?

Will you collect data using (a) the i-Tree Storm PDA tool, (b) paper forms for manual data entry, or (c) a non-i-Tree platform?

The Storm software package includes a PDA application for use in data collection. Significant updates have been made for i-Tree v. 3.0, and the PDA application now works seamlessly from within Storm. The program will work with Pocket PC devices running Window's Mobile 2003 (or later).

If your community lacks funding to support the use of PDAs or you simply prefer to use an alternate method, that's no problem. Data collection can be conducted using the paper forms in the Appendix, spreadsheets, etc. If you use the paper forms, data can later be entered directly into Storm's Excel Template. If you would like to use a non-i-Tree platform, look over the data requirements on the forms to get an idea of what is needed. It's a good idea to have the paper forms ready no matter what your decision, as storm-related power outages are likely.

Data Collection Method?

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 143 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 tornadoes 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 their 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 440 total miles of city streets were impacted by the storms.
- 18.1 % of Springfield's streets showed some damage to the public trees growing on them.
- approximately 1,000 of the 5,800 streets trees, growing in the impacted areas, were destroyed or severely damaged, necessitating removal.
- Immediate impacts include the reduction of rainwater interception by 2,444,161 gallons.
- Reduced storage of 7,220,341 pounds of carbon.
- Approximately 441,161 pounds of sequestered CO^2 has been lost.

For more information please contact:

David N. Bloniarz
US Forest Service Northern Research Station
Amherst, MA

Alexander M. Sherman
City of Springfield
Assistant City Forester

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

Canopy Analysis of Springfield Tornado Zone

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 110 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 tornadoes 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 a 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.

For more information please contact:

David V. Ellerbelo
US Forest Service Northern Research Station
Amherst, MA

Alexander K. Eberman
City of Springfield
Assistant City Forester

i-Tree
Canopy

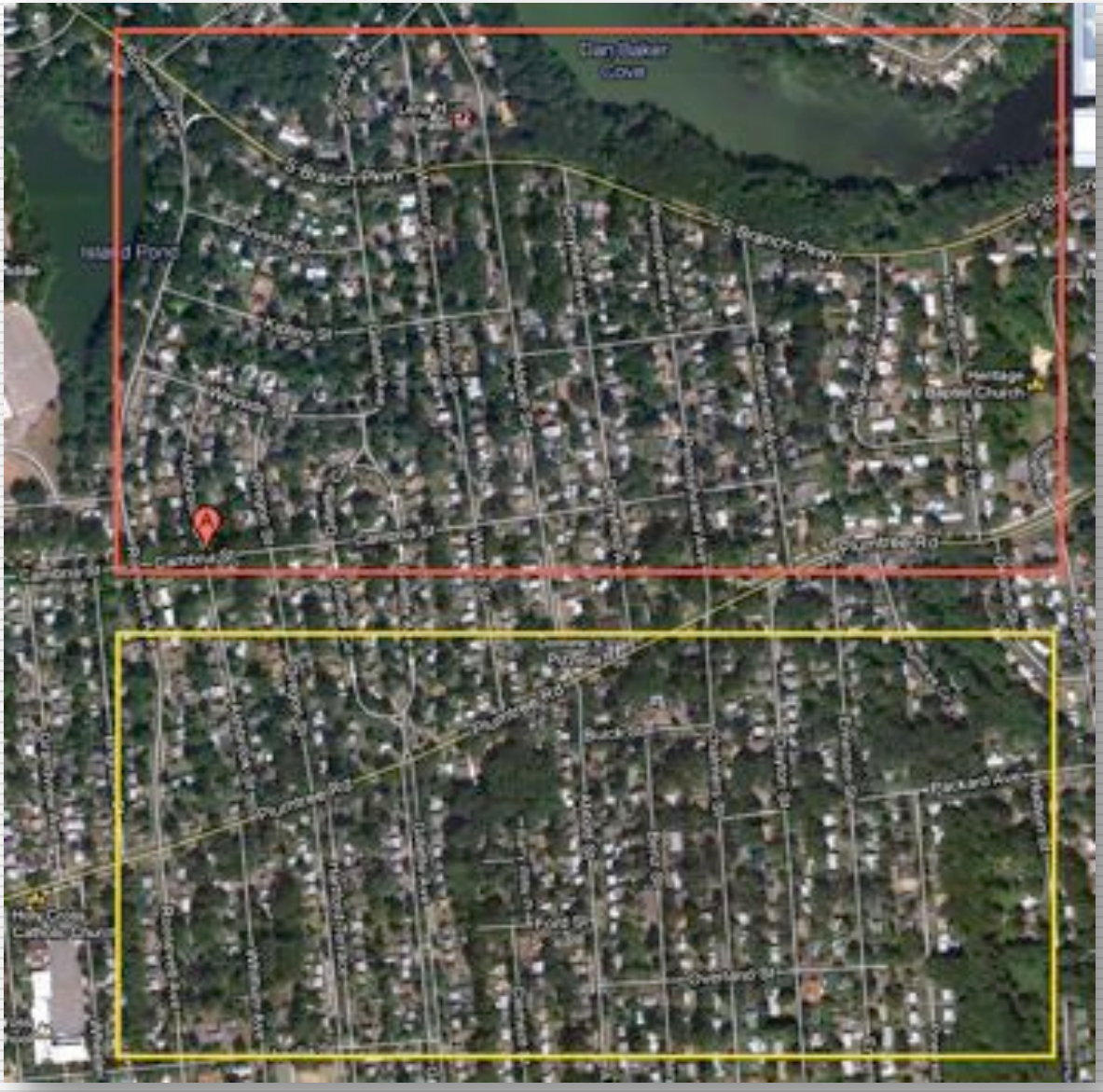
i-Tree Canopy Analysis of Springfield Tornado Zone

- 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.

Micro-climate Changes in Springfield's Tornado Zone

Northern Research Station
USDA Forest Service

Forest Service
U.S. Department of Agriculture



Micro-climate Changes in Springfield's Tornado Zone

Northern Research Station
USDA Forest Service

Forest Service
U.S. Department of Agriculture

Micro-climate Changes in Springfield's Tornado Zone

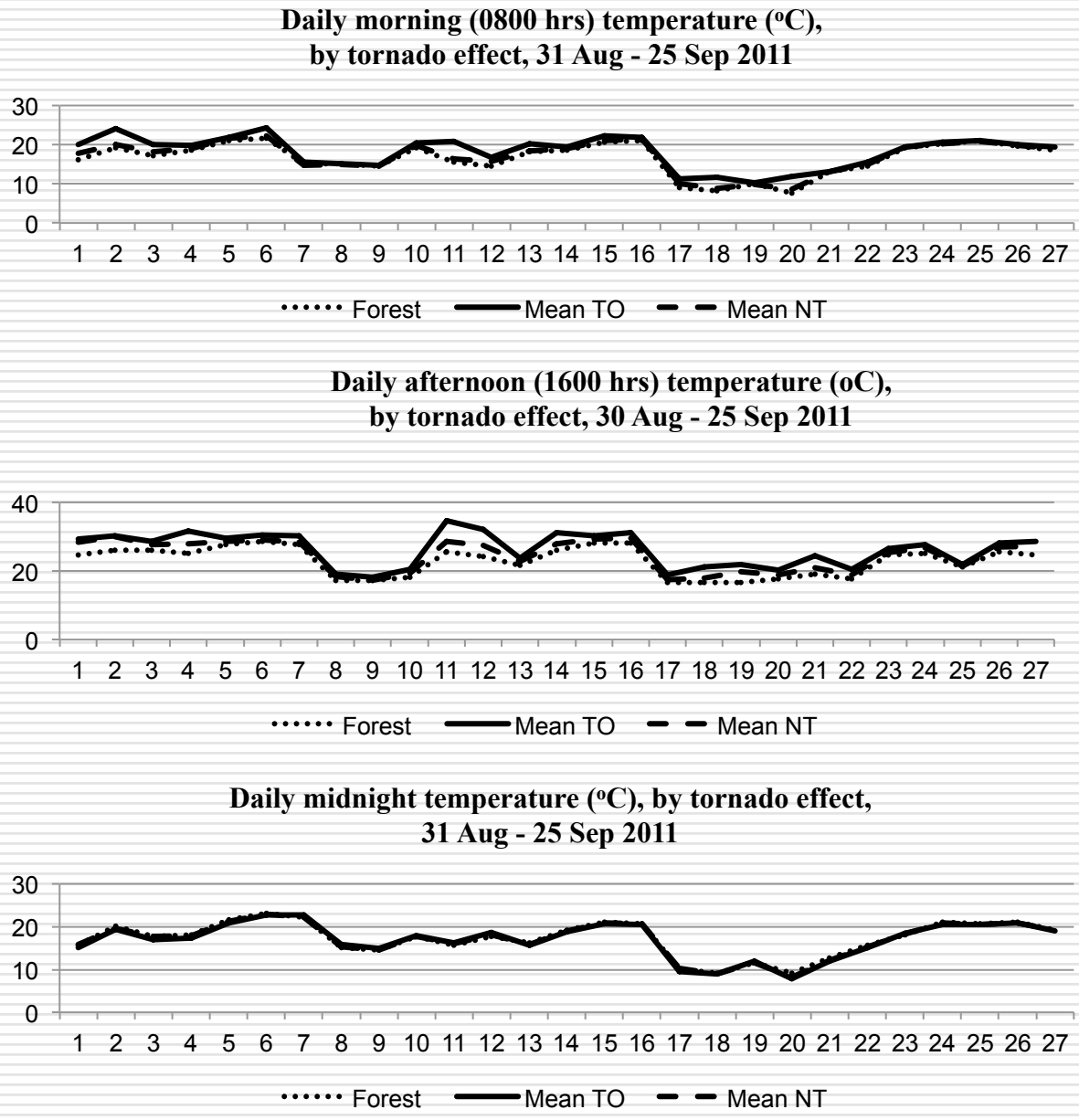
Northern
RESEARCH STATION
USDA Forest Service

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Micro-climate Changes in Springfield's Tornado Zone

	Tornado	Non-tornado	Forest
% canopy cover	0.8	44.2	91.7
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.



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Wrap-Up

- Questions
- Discussion
- Other Points