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## **UFORE Quick Start Guide For the complete inventory method**

### **Introduction**

The Urban Forest Effects model (UFORE) as outlined in the i-Tree User's Manual is designed to be used to collect data in various random plots within a study area. However, the model can be used to inventory all trees in an area such as a park, private residence, office complex, etc. Although the results of a complete inventory do not provide as much information as the results from a sample inventory, you will be provided with good forest structure analysis, pollution removal information, carbon sequestration and storage results, and CTLA tree/forest value data. This guide is designed to help you easily design and implement a complete inventory project using the UFORE model. In this guide, section numbers in parentheses refer to where you can find more information about the particular topic in the i-Tree User's Manual. This method is not currently supported by i-Tree, but is supported by the designers of the UFORE model (David Nowak, USDA Forest Service, Northeast Research Station, Syracuse, NY).

### **UFORE complete inventory: steps to get started**

#### **1. What is the objective of your inventory?**

The first thing you need to understand is why you are doing an inventory and what information you would like to obtain from it. Establish your inventory's goals and objectives. A UFORE complete inventory will provide information per tree about canopy coverage, leaf area and biomass, carbon storage and gross sequestration, CTLA tree value, annual pollution (CO, O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub>) removal as well as annual biogenic volatile organic compounds released. These data are also summarized for the entire inventoried area.

#### **2. How do you want to collect the data?**

Paper data sheets

Portable equipment (i.e. GPS unit or data recorder)

The data required for a UFORE inventory must be collected and stored in a certain format (see UFORE Tree Data Spreadsheet Format below). Data must be stored in a Microsoft Excel spreadsheet and labeled "tree.xls". You can create your own paper data sheets following the required format. In the same way, you can collect data using portable equipment such as a GPS unit or a field computer that has spreadsheet capabilities. If this method is used, you must format the data fields according to the UFORE format (see UFORE Tree Data Spreadsheet Format below).

**Note:** using GPS to locate trees spatially is very useful when managing them over time. The trees can then be represented and maintained in a GIS layer.

### **3. Format spreadsheet fields**

For a complete inventory, all fields must be present in the file even though not all fields will be used. If using GPS equipment with Trimble Technology, a data dictionary is available for download at [www.urbanforestrysouth.org](http://www.urbanforestrysouth.org) keyword “UFORE data dictionary”.

### **4. Review UFORE data field defaults** (i-Tree User’s Manual Sec. 1.7.4 and Appendix C)

Data for a UFORE project is quite precise. It takes practice to train your eyes for UFORE data collection. It would be a good idea to learn what data are required and how to collect them before starting a project. Remember, if a field will not be used, make sure its data cell is populated with the appropriate null value.

### **5. Collect field data** (Sec. 1.7.4 and Appendix C)

A team of two to three people is usually necessary to properly assess trees; one person to record the data and collect GPS information and another one or two people to assess the tree and feed the information to the data recorder.

### **6. Send data set to USDA Forest Service for analysis**

After collecting your data, making sure the data are formatted properly in the data set, and the data are in a Microsoft Excel file named “trees.xls”, you are ready to send the data off for analysis. Currently for UFORE analysis, data must be sent to the Northeastern Research Station in Syracuse, NY to be processed. To schedule and discuss a UFORE analysis, please contact David J. Nowak at [dnowak@fs.fed.us](mailto:dnowak@fs.fed.us).

### **7. Generate structure, pollution, and value reports**

Data giving structural analysis, pollutant removal, and replacement values will be summarized per plot if you have multiple areas that were inventoried. Graphic reports can be generated in Excel by using PivotChart and Pivot Table reports. These reports can be used to develop a comprehensive management plan for the area of interest.

## UFORE Tree Data Spreadsheet Format

(Tree data criteria is found in section 1.7.4 and in Appendix C)

Spreadsheet Column	Field Name	Description of Field
A	PLOT #	The plot identification number if multiple plots – default = 1
B	SPECIES	UFORE alphanumeric species code (see below) *
C	#DBHs	Number of stems of tree at breast height
D	DBH1	Diameter at breast height of stem #1
E	DBH2	Diameter at breast height of stem #2 (leave blank if not applicable)
F	DBH3	Diameter at breast height of stem #3 (leave blank if not applicable)
G	DBH4	Diameter at breast height of stem #4 (leave blank if not applicable)
H	DBH5	Diameter at breast height of stem #5 (leave blank if not applicable)
I	DBH6	Diameter at breast height of stem #6 (leave blank if not applicable)
J	TREE HT	Height of tree
K	BOLE HT	Height to the base of the live crown
L	CRWN WIDTH	Mean of crown width in N-S and E-W directions
M	DIEBACK	Alphabetic code for dieback (see below) #
N	% AREA	Not needed for complete inventory – default = “.”
O	% Missing	Percent of tree canopy missing (not including dieback)
P	TREE ID	Unique tree identification number
Q	SHRB IND	For complete inventory all entries will be “T” (for tree)
R	NO. BLDGS	Not needed for complete inventory – default = 0
S	STREET	Indicates city street tree or not (enter Y for yes & N for no)
T	CLE	Crown light exposure value

Save this file with all of your tree data as “tree.xls”

\* UFORE alphanumeric codes for trees and shrubs can be found on the Northern Research Station’s website at <http://www.fs.fed.us/ne/syracuse/Tools/UFORE.htm>

# Dieback codes: E=<1% dieback; G=1-10%; F=11-25%; P=26-50%; C=51-75%; D=76-99%; K=100%

Sample data format for a UFORE complete inventory

PLOT#	SPECIES	#DBHs	DBH 1	DBH 2	DBH 3	DBH 4	DBH 5	DBH 6	TREE HT	BOLE HT	CRWN WIDTH	DIEBACK	% AREA	% MISSING	TREE ID	SHRB IND	#BLDGS	STREET	CLE
1	CULE	6	4	4	3	3	2	2	19	1	15	E	.	5	1	T	0	N	5
1	COFL	5	3	4	4	1	1		10	3	16	E	.	50	2	T	0	Y	3
1	QUPH	1	4						18	5	14	E	.	35	3	T	0	Y	4
1	QUPH	1	32						64	7	61	E	.	35	4	T	0	Y	3
1	QUPH	1	34						70	10	54	E	.	65	5	T	0	Y	2
1	QUPH	1	24						75	21	45	G	.	65	6	T	0	Y	2
1	QUPH	1	22						73	11	42	G	.	60	7	T	0	Y	2
1	QUPH	1	28						65	11	55	E	.	60	8	T	0	Y	2
1	QUPH	1	25						70	12	55	G	.	45	9	T	0	Y	2
1	QUPH	1	26						65	12	58	G	.	50	10	T	0	Y	3
1	QUPH	1	27						70	9	51	G	.	25	11	T	0	Y	5
1	QUPH	1	22						65	10	53	G	.	30	12	T	0	Y	3
1	QUPH	1	28						73	10	51	G	.	65	13	T	0	Y	2
1	QUPH	1	28						79	12	60	G	.	50	14	T	0	Y	2
1	QUPH	1	28						77	12	53	G	.	55	15	T	0	Y	2
1	QUPH	1	28						77	10	54	F	.	50	16	T	0	Y	2
1	QUPH	1	35						80	12	66	F	.	55	17	T	0	Y	2
1	QUPH	1	33						77	15	55	E	.	50	18	T	0	Y	2
1	QUPH	1	23						48	11	40	G	.	50	19	T	0	Y	4
1	COFL	2	5	3					15	3	18	E	.	15	20	T	0	N	4
1	TADI	1	19						48	7	20	E	.	0	21	T	0	N	5
1	ACRU	1	13						37	3	18	F	.	40	22	T	0	N	3
1	ACRU	3	8	3	2				33	2	13	G	.	50	23	T	0	N	2
1	ACRU	1	12						28	2	18	G	.	50	24	T	0	N	2
1	ULAL	1	17						44	12	36	G	.	65	25	T	0	Y	2
1	ULAL	1	13						48	10	38	F	.	65	26	T	0	Y	3
1	ULAL	1	13						44	15	39	G	.	50	27	T	0	Y	3
1	ACRU	6	3	3	3	3	4	4	22	3	24	E	.	15	28	T	0	Y	5

Sample inventory output giving individual tree and whole area carbon storage and annual sequestration, CTLA value, leaf biomass and area values.

TREE#	GENUS	SPECIES	DBH (cm)	HEIGHT (m)	AREA (m <sup>2</sup> )	TREE CONDITION	LEAF AREA (m <sup>2</sup> )	LEAF BIOMASS (kg)	LAI	CARBON STORAGE (kg)	GROSS CARBON SEQ. (kg/yr)	TREE VALUE (\$)	STREET TREE	NATIVE TO STATE
1	Cupressocyparis	na	19.3	5.8	16.4	Excellent	6.58	1.54	0.4	32.7	5.59	688	NO	NO
2	Cornus	florida	16.7	3	18.7	Excellent	24.07	1.4	1.29	45.77	10.06	606	YES	YES
3	Quercus	phellos	10.2	5.5	14.3	Excellent	14.82	1.31	1.04	8.9	2.83	242	YES	YES
4	Quercus	phellos	81.3	19.5	271.5	Excellent	307.17	27.25	1.13	1484.02	61.05	7,901	YES	YES
5	Quercus	phellos	86.4	21.3	212.8	Excellent	460.87	40.88	2.17	1810.37	69.69	8,812	YES	YES
6	Quercus	phellos	61	22.9	147.8	Good	324.85	28.82	2.2	1001.89	51.63	4,433	YES	YES
7	Quercus	phellos	55.9	22.3	128.7	Good	272.8	24.2	2.12	828.92	46.33	3,771	YES	YES
8	Quercus	phellos	71.1	19.8	220.7	Excellent	434.7	38.56	1.97	1170.72	53.78	6,243	YES	YES
9	Quercus	phellos	63.5	21.3	220.7	Good	330.99	29.36	1.5	1013.91	50.84	4,786	YES	YES
10	Quercus	phellos	66	19.8	245.5	Good	396.71	35.19	1.62	1018.06	49.85	5,153	YES	YES
11	Quercus	phellos	68.6	21.3	189.8	Good	208.76	18.52	1.1	1172.24	54.95	5,535	YES	YES
12	Quercus	phellos	55.9	19.8	205	Good	201.83	17.9	0.98	743	42.12	3,771	YES	YES
13	Quercus	phellos	71.1	22.3	189.8	Good	417.25	37.01	2.2	1306.09	58.97	5,931	YES	YES
14	Quercus	phellos	71.1	24.1	262.7	Good	437.67	38.83	1.67	1407.05	62.84	5,931	YES	YES
15	Quercus	phellos	71.1	23.5	205	Good	381.29	33.82	1.86	1373.45	61.55	5,931	YES	YES
16	Quercus	phellos	71.1	23.5	212.8	Fair	359.83	31.92	1.69	1373.45	61.55	5,119	YES	YES
17	Quercus	phellos	88.9	24.4	317.8	Fair	573.8	50.9	1.81	2168.55	79.67	7,591	YES	YES
18	Quercus	phellos	83.8	23.5	220.7	Excellent	367.77	32.62	1.67	1872.16	72.76	8,359	YES	YES
19	Quercus	phellos	58.4	14.6	116.7	Good	174.83	15.51	1.5	607.1	34.65	4,095	YES	YES
20	Cornus	florida	14.8	4.6	23.6	Excellent	13.18	0.77	0.56	34.6	8.61	319	NO	YES
21	Taxodium	distichum	48.3	14.6	29.2	Excellent	0	0	0	281.6	19.25	2,648	NO	YES
22	Acer	rubrum	33	11.3	23.6	Fair	65.53	4.41	2.77	249.03	26.6	1,280	NO	YES
23	Acer	rubrum	22.3	10.1	12.3	Good	35.02	2.36	2.84	98.3	15.78	834	NO	YES
24	Acer	rubrum	30.5	8.5	23.6	Good	59.94	4.04	2.54	206.08	23.91	1,306	NO	YES
25	Ulmus	alata	43.2	13.4	94.6	Good	271.95	19.65	2.88	371.72	30.6	1,600	YES	YES
26	Ulmus	alata	33	14.6	105.4	Fair	288.66	20.85	2.74	195.32	21.18	949	YES	YES
27	Ulmus	alata	33	13.4	111	Good	216.08	15.61	1.95	195.32	21.18	1,099	YES	YES
28	Acer	rubrum	20.9	6.7	42	Excellent	31.84	2.14	0.76	84.86	14.53	811	YES	YES
	INVENTORY	TOTAL			3882.7		6678.8	575.39		22155.17	1112.35	105,741		

Sample inventory pollution output giving individual tree and whole area annual pollution removal and values as well as BVOC emissions.

PLOT#	NUMBER	SCIENTIFIC	NAME	Annual Pollution Removed (g)						Annual Removal Values (U.S. \$)						Annual VOC Emissions (g)			TOTAL VOC
				CO	O3	NO2	PM10	SO2	TOTAL	CO	O3	NO2	PM10	SO2	TOTAL	ISOPRENE	MONOTERP.	OVOC	
1	1	Quercus	alba	54.094	175.332	112.157	516.636	59.161	917.381	0.0485	4.8205	0.7573	2.329	0.0978	8.0531	1635.245	21.027	183.928	1840.2
1	2	Liriodendron	tulipifera	25.288	81.963	52.431	238.849	27.656	426.186	0.0227	2.2534	0.354	1.0767	0.0457	3.7526	1.092	9.83	85.982	96.903
1	3	Quercus	alba	29.571	95.847	61.312	217.265	32.341	436.335	0.0265	2.6352	0.414	0.9794	0.0535	4.1086	893.92	11.495	100.546	1005.96
1	4	Liriodendron	tulipifera	49.467	160.333	102.562	350.981	54.1	717.443	0.0444	4.4081	0.6925	1.5822	0.0894	6.8166	2.136	19.228	168.193	189.558
1	5	Ilex	opaca	4.319	13.999	8.955	16.009	4.723	48.005	0.0039	0.3849	0.0605	0.0722	0.0078	0.5292	0.203	2.073	18.13	20.406
1	6	Comus	florida	4.563	14.788	9.46	43.789	4.99	77.589	0.0041	0.4066	0.0639	0.1974	0.0082	0.6802	0.197	14.188	15.513	29.898
1	286	Quercus	alba	21.438	69.484	44.448	148.973	23.446	307.788	0.0192	1.9104	0.3001	0.6716	0.0388	2.94	648.047	8.333	72.891	729.271
1	287	Quercus	alba	39.115	126.781	81.1	293.658	42.779	583.433	0.0351	3.4857	0.5476	1.3238	0.0707	5.4629	1182.433	15.204	132.997	1330.634
1	288	Cunninghamia	lanceolata	5.426	17.587	11.25	20.064	5.934	60.26	0.0049	0.4835	0.076	0.0904	0.0098	0.6646	0.256	39.058	22.777	62.09
<b>Plot 1</b>	<b>TOTAL</b>			<b>4031.443</b>	<b>13066.77</b>	<b>8358.636</b>	<b>29325.8</b>	<b>4409.047</b>	<b>59191.66</b>	<b>3.6171</b>	<b>359.2502</b>	<b>56.4365</b>	<b>132.2021</b>	<b>7.2864</b>	<b>558.7937</b>	<b>80769.253</b>	<b>5467.043</b>	<b>14234.84</b>	<b>100471.1</b>
2	289	Quercus	nigra	20.589	66.733	42.688	121.511	22.517	274.038	0.0185	1.8347	0.2882	0.5478	0.0372	2.7264	622.389	8.003	70.005	700.396
2	290	Quercus	nigra	4.503	14.596	9.337	23.394	4.925	56.756	0.004	0.4013	0.063	0.1055	0.0081	0.582	136.135	1.75	15.312	153.197
2	291	Quercus	nigra	4.884	15.83	10.126	24.638	5.342	60.821	0.0044	0.4352	0.0684	0.1111	0.0088	0.6279	147.643	1.898	16.607	166.148
2	333	Quercus	alba	25.257	81.863	52.366	181.103	27.622	368.21	0.0227	2.2507	0.3536	0.8164	0.0457	3.489	763.496	9.817	85.876	859.19
2	334	Robinia	pseudoacacia	10.513	34.076	21.798	84.452	11.498	162.338	0.0094	0.9369	0.1472	0.3807	0.019	1.4932	317.814	4.087	35.747	357.647
<b>Plot 2</b>	<b>TOTAL</b>			<b>863.257</b>	<b>2798.002</b>	<b>1789.839</b>	<b>5886.346</b>	<b>944.108</b>	<b>12281.56</b>	<b>0.7746</b>	<b>76.9269</b>	<b>12.0848</b>	<b>26.5357</b>	<b>1.5602</b>	<b>117.8826</b>	<b>22938.614</b>	<b>1029.075</b>	<b>3014.957</b>	<b>26982.64</b>
3	637	Quercus	rubra	48.991	158.791	101.576	328.819	53.58	691.758	0.044	4.3657	0.6858	1.4823	0.0886	6.6664	1480.977	19.043	166.577	1666.597
3	638	Morus	rubra	20.246	65.622	41.977	117.219	22.142	267.207	0.0182	1.8042	0.2834	0.5284	0.0366	2.6708	0.874	7.87	68.839	77.583
3	639	Quercus	alba	9.469	30.691	19.633	94.448	10.356	164.597	0.0085	0.8438	0.1326	0.4258	0.0171	1.4278	286.246	3.681	32.196	322.123
3	640	Quercus	alba	7.677	24.883	15.917	61.773	8.396	118.646	0.0069	0.6841	0.1075	0.2785	0.0139	1.0908	232.068	2.984	26.102	261.155
<b>Plot 3</b>	<b>TOTAL</b>			<b>4108.51</b>	<b>13316.54</b>	<b>8518.385</b>	<b>28008.04</b>	<b>4493.305</b>	<b>58444.81</b>	<b>3.6883</b>	<b>366.1175</b>	<b>57.5176</b>	<b>126.2607</b>	<b>7.4278</b>	<b>561.0082</b>	<b>75521.922</b>	<b>4113.996</b>	<b>14142.02</b>	<b>93777.92</b>
4	1282	Comus	florida	13.824	44.808	28.663	124.202	15.119	226.617	0.0124	1.2319	0.1935	0.5599	0.025	2.0228	0.597	42.989	47.005	90.591
4	1283	Acer	saccharum	16.085	52.135	33.35	111.68	17.591	230.841	0.0144	1.4334	0.2252	0.5035	0.0291	2.2055	0.695	50.019	54.691	105.404
4	1284	Prunus	serotina	5.527	17.915	11.46	29.317	6.045	70.264	0.005	0.4925	0.0774	0.1322	0.01	0.717	0.239	1.077	18.837	20.153
4	1285	Acer	saccharum	2.799	9.072	5.803	23.035	3.061	43.77	0.0025	0.2494	0.0392	0.1038	0.0051	0.4	0.121	8.704	9.517	18.342
<b>Plot 4</b>	<b>TOTAL</b>			<b>13144.46</b>	<b>42604.14</b>	<b>27253.22</b>	<b>78250.95</b>	<b>14375.63</b>	<b>175628.4</b>	<b>11.7921</b>	<b>1171.333</b>	<b>184.0141</b>	<b>352.7543</b>	<b>23.7632</b>	<b>1743.659</b>	<b>187649.125</b>	<b>22749.908</b>	<b>46865.14</b>	<b>257264.2</b>
5	1371	Prunus	yedoensis	18.934	61.369	39.257	122.86	20.707	263.127	0.017	1.6872	0.2651	0.5539	0.0342	2.5574	0.818	3.688	64.528	69.035
5	1372	Prunus	yedoensis	7.218	23.396	14.966	60.701	7.894	114.176	0.0065	0.6432	0.1011	0.2736	0.013	1.0375	0.312	1.406	24.601	26.319
5	1373	Prunus	yedoensis	5.781	18.737	11.986	40.5	6.322	83.326	0.0052	0.5151	0.0809	0.1826	0.0105	0.7943	0.25	1.126	19.701	21.077
<b>Plot 5</b>	<b>TOTAL</b>			<b>261.018</b>	<b>846.013</b>	<b>541.185</b>	<b>1912.117</b>	<b>285.467</b>	<b>3845.806</b>	<b>0.2347</b>	<b>23.2596</b>	<b>3.6544</b>	<b>8.6198</b>	<b>0.4716</b>	<b>36.2398</b>	<b>710.254</b>	<b>342.558</b>	<b>888.06</b>	<b>1940.872</b>