A User Guide for CUFIM, the

Community and Urban Forest Inventory and Management Program

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Preface

The Community and Urban Forest Inventory and Management program (CUFIM) is one more step in answer to the call for improved management and sustainability of California's urban forests.

This report presents an Excel-based computer program that can be used to setup and maintain a tree inventory and database, and to evaluate the urban forest in quantative terms including volume and value. It is the hope of the authors that this effort will help urban communities take the next step toward sustainability of the urban forest resource.

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A user's guide to CUFIM, the…

Community and Urban Forest Inventory and Management Program

I. Introduction

The purpose of this study is to help communities manage their urban forests specifically in relation to the potential use of woody biomass rather than the more traditional and costly practice of disposal.

This study builds on two previous studies that provided the foundation and direction for this effort. The Elements of Sustainability in Urban Forestry by Richard Thompson, Norman Pillsbury and Richard Hanna (1994) examined urban forestry in California and identified the elements necessary for sustainability to occur. This study also motivated the development of urban tree volume equations (Tree Volume Equations for Fifteen Urban Species in California by Norman Pillsbury, Jeffrey Reimer and Richard Thompson, 1998) where detailed estimates of the biomass potential for various urban species is now possible.

Presented here is CUFIM, the Community and Urban Forest Inventory and Management program, a new Excel-based computer program that allows urban foresters control over their tree inventory. It also allows unprecedented options to determine volume of anticipated tree removals, and estimates of their dollar value.

This program allows users to store and maintain up to 500 tree species and 50,000 tree records. Each record contains the following fields: Tree sequence number, tree record number, species code, removal status, species name, species group, tree dbh, tree height, tree volume including a breakdown of volume by branch diameter size, and 10 user-defined variables that can be easily inputted by the user.

Each species that is added to the database is also assigned a species group code. This is used to calculate tree volume information. CUFIM comes with 19 built-in species groups, and allows for a total of 50 groups by the user. If new species groups are to be entered, their local or standard volume coefficients must also be entered as described in this report.

The documentation and notes provide assistance to the user including suggestions for setting up the database, the recommended precision of measurement units, and diameter and height class interval requirements. A number of examples are included to illustrate main points.

Three separate functions are available for ease in adding, changing or deleting tree records. Basic tree statistics such as number of species, size of database, averages of dbh, height and volume, as well as total volume and volume by diameter class are available.

Several spreadsheets are devoted to estimating tree volume and value from trees that would be removed from the forest each year. Options include limiting the range of diameters, as well as the species of tree that would be included and/or excluded in volume calculations. The program is designed for beginners, but as skill levels increase, a number of advanced options are also available.

A number of different kinds of tables can be printed that provide hard copy of the database, and summarize the number of trees and volume by diameter class. Biomass value can also be assessed through three different approaches.

In the future, potentially, communities can market their biomass for wood products and show an income from the woody resource rather than only a cost for maintenance and disposal.

II. Procedures and Methods

The authors canvassed 20 communities in California to determine the type of street tree databases that were currently being used in order to understand the benefits and limitations of these programs. Four communities allowed us access to their database so we could examine how they were used and what difficulties they were experiencing.

The results varied from community to community. Some communities have contracted with consultants to manage their entire street tree inventory. This allows the community to focus their resources on other needs, and seems to have provided some level of assurance that consistency and accuracy would be maintained over time. There is also the sense that periodic updates would continue. A disadvantage of this approach is the loss of contact with the process itself. Very few knew much about the system, and felt that making changes to the inventory procedures that were initially agreed upon would not be easy, and therefore wouldn't happen.

Other communities have maintained their own database and developed a process that is tailored to their needs, in the best way possible. None of the street tree inventory programs we learned about were designed to address volume and wood value issues relating to inventory. This means that regardless of their dedication to this process, such information cannot be obtained. Communities in general do not understand the difficulty of keeping an inventory up to date, especially given that personnel often change. The last person in charge may have kept the task high priority while the next person did not.

Some urban foresters expressed frustration because the information that is generated from existing inventory programs hasn't been helpful in convincing others in their organization of the value of the forest. Supervisors and administrators often view inventory work as low priority activities that can be farmed out, postponed for many years, or dropped altogether.

These issues complicate the goals of urban forest management. If inventory programs don't provide desirable information for decision makers, and if people aren't trained to run the programs, especially when new employees take over, then a different approach is needed if urban wood is to be utilized and valued.

The authors have tried to address the limitations discussed above through the development of an Microsoft Excel® based computer program titled "Community and Urban Forest Inventory and Management" or CUFIM. We recognize that no single approach will solve all of these issues. However, our objectives in developing this program focus on the following issues.

1. The program must be designed so that semi-computer literate people could use it without extensive training. This means that one does not have to be a computer programmer to run the program. Also, as work force changes occur in an organization, the program must be "simple" enough so that new hands can pick up where others left off.

2. On-the-other-hand, the program must be sophisticated enough to address inventory from the standpoint of quantity of wood and value of the resource. To date, this is what has been missing and why street tree inventory programs are not taken seriously in the urban forestry budgeting process.

3. The program must be flexible enough so that existing data parameters can be changed, and new parameters can be added as needs arise.

As we alluded earlier, it would require a "super program" and "super people" to achieve this goal. Yet, there is room for significant improvement in the way inventories are managed, and the computer program presented here takes major steps in that direction. And, as with any program, there are limitations with this one as well.

The choice to select Microsoft Excel® was made for several reasons.

1. Excel is the most universally understood database program in the world. While it technically is not a true database program, it does include most of the major elements needed in a database program and can be used very effectively for this purpose.

2. Nearly all, if not all, graduates from universities have worked with Excel spreadsheets. This means they already have some level of expertise. While it may be minimal for some, it will be considerable for others.

3. Learning how to use the spreadsheets developed for this program is not a difficult task for those with some spreadsheet background. If personal changes occur in a community, new people will have an easier time of picking up the system.

4. As time progresses, the expertise levels of spreadsheet users will increase, not decrease. Therefore, over time, the use of a program developed in Excel will become easier and users will become more proficient.

5. Users will know or be able to quickly learn how to backup the database because they will already understand their computers' operating system.

There are also some limitations with the use of Excel.

1. As mentioned earlier, it is not a true database program. One impact of this is that the speed of the program will decrease as the database increases. This is not significant on fast computers, but for older, slower computers, it would be problematic. Also, some routines may take several minutes to perform even with fast computers. On the plus side, every new generation of computers sports a dramatic increase in speed. In time, this will not be viewed as a problem.

2. The size of the database is more limited through Excel. For example, the program presented here allows a maximum of 50,000 trees. This limit was selected because larger numbers could slow the program below the willing attention span of many users. This size will be adequate for small- and medium-sized communities, however, large cities would have to break their database into several geographic units to benefit from the program. This problem will also diminish with faster computers.

3. This program is not protected in the same way that computer applications are protected. While this is possible, doing so has disadvantages. By leaving the source code open, users with higher levels of expertise, can make changes to meet changing needs. This flexibility can be very valuable to a community.

   However, there is the difficulty of protecting the database from unwanted entries and user errors. The disadvantage is that important information could be lost, or parts of the program would not work, if the user does not adhere to the rules and procedures. All is not lost, however, because of backups, and failing that, there are many people around that could fix an Excel problem. Colleges and businesses are a good source of spreadsheet expertise.

The reader can see that we have tried to balance the need for ease and flexibility of use with the need for a program that is capable of providing quantitative data from a substantial database.

III. CUFIM Program Overview

CUFIM, the Community and Urban Forest Inventory and Management program, is a powerful yet fairly straight-forward program to use. It can be taught to users who use Excel regularly in about 2 hours; new users will require more time.

It has many features, and an understanding of its capabilities will enable the user to develop and set up their own database.

A user who is first beginning to set up a database and collect tree data will find this program ideal to work with. If an existing database is to be brought into the program, the reader is referred to Appendix A for instructions. Regardless, understanding how the program is designed will greatly aid the user.

CUFIM is an Excel spreadsheet program written with a combination of Excel functions, simple macros, and programming through the Visual Basic Application. The user does not need to understand functions, macros or Visual Basic to run the program. CUFIM is 1 file consisting of 8 sheets containing 14 steps for completion.

There are two major sections of the program (see Figure 1). Section A addresses tree inventory, database setup, and maintenance activities. This includes built in tree parameters such as species, species' code, volume equations if available, tree dbh, and total height.

Section B is more advanced. It computes tree removal volume and value information, and allows the user to make projections of volume and potential income from trees slated for removal. The user can set constraints on the data set. For example, the minimum and/or maximum tree diameter can be defined which restricts the analysis to those limits.

The program is designed so that a beginner can use just the sections needed, and as his or her skill level increases, more sophisticated analyses can be accomplished.

An expanded outline that shows the procedural steps are provided on page 6.

VERY IMPORTANT NOTE:

When typing on the spreadsheet, it is very important to observe these rules. Failure to follow them may result in incorrect calculations or the program might even stop working.

1. Do not type in any cell unless it is YELLOW.
2. Do not click in any cell unless it is YELLOW.
3. Do not tab or return into any cell unless it is YELLOW.

It is OK to click on list boxes, check boxes, radio or square boxes as required. These can be unselected by clicking on them a second time.

Figure 1

Flow Chart for CUFIM…

Community and Urban Forest Inventory and Management

Section A. Tree Inventory and Database Setup and Maintenance

Sheet 1 - Program Identification

Identify your urban forestry program

Sheet 2 - Database Setup

Database Entries:
- Species
- Species' codes
- Volume equations

Find advice on setting up measurement units.

Sheet 3 - Enter Tree Data in Database

Create & Maintain Tree Database and Inventory

Three Primary Functions:
- Add New Tree Record
- Change Existing Tree Record
- Delete Unwanted Tree Record

Print Database

Sheet 4 - Tree Inventory Statistics

Inventory Statistics for dbh, height, and volume include:
- Average
- Standard deviation
- Minimum value
- Maximum value
- No. of trees in database
- No. of trees by dbh class
- Volume of trees by dbh class

Section B. Tree Removal Volume and Value Calculations

Sheet 5 - Define Output Parameters for Volume & Value of Removal Trees

Set the following parameters:
- Minimum diameter
- Maximum diameter
- Species to be excluded
- Only the species to be included

Sheet 6 - Estimating the Volume of Tree Removal per Year

Method 1A: Estimating volume from the PERCENT of all trees to be removed

Method 1B: Estimating volume from the percent of trees by DBH CLASS

Sheet 7 - Tree Management Options

Creating Stand Tables for removal trees (no. of trees per diameter class by species group)

Creating Stock Tables for removal trees (tree volume per diameter class by species group)

Sheet 8 - Preliminary Valuation

Computing the volume and value by the "Same Value Method"

Computing the volume and value by the "Assign Value Method"

Outline of Showing Procedural Steps of CUFIM.

Sheet	Sheet Name	Full Name	Procedural Steps	
SECTION A. TREE INVENTORY, DATABASE SETUP AND MAINTENANCE.				
1	ID	Program Identification	Step 1.	Name of Urban Forestry Unit
2	SETUP	Database Setup	Step 2.	Species and Species' Code
			Step 3.	Enter New Volume Equations
			Step 4.	Advice on Setting up Measurement Units
3	DATABASE	Enter Tree Data in Database	Step 5.	Create and Maintain Tree Database Inventory
4	STATS	Generate Basic Tree Inventory Statistics	Step 6.	Generate Basic Statistics for Tree Inventory
SECTION B. TREE REMOVAL VOLUME AND VALUE CALCULATIONS.				
5	OUTPUT PARAMETERS	Define Removal Parameters for Output	Step 7.	Range of Tree Diameters to be Included in Volume Calculation of Removal Trees
			Step 8.	Indicate Species to be Excluded from Volume Calculation of Removal Trees
			Step 9.	Indicate Only the Species to be Included in Volume Calculation of Removal Trees
6	REMOVAL	Estimating the Volume of Tree Removal per Year	Step 10.	Estimating the Annual Volume of Tree Removal by Randomly Selecting Trees, or by Field Marking Trees.
7	MGT OPTIONS	Tree Management Options	Step 11a.	Creating Stand Tables for Removal Trees
			Step 11b.	Creating Stand Tables for ALL Trees in Database
			Step 12a.	Creating Stock Tables for Removal Trees
			Step 12b.	Creating Stock Tables for ALL Trees in Database
8	VALUATION	Preliminary Valuation	Step 13.	Preliminary Valuation - Same Value Method
			Step 14.	Preliminary Valuation - Assign Value Method

IV. How to Set up Your Inventory

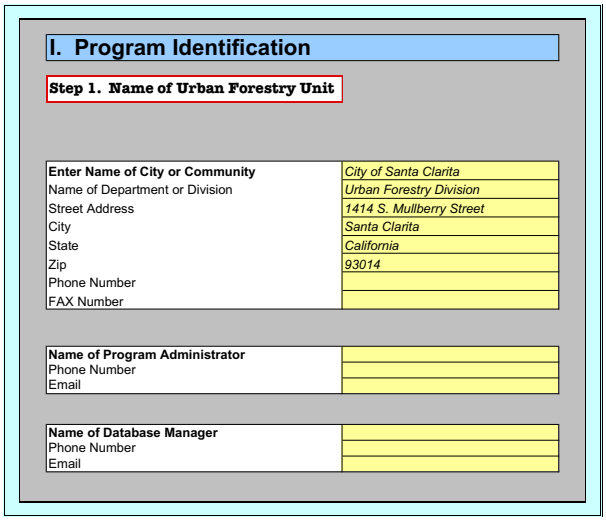
SECTION A. TREE INVENTORY, DATABASE SETUP AND MAINTENANCE.

Having a good plan for your database is crucial to obtaining success when using it. This section is presented to assist the user in designing a database that can be used with CUFIM, and walks the user through the various steps required for setup.

Sheet 1 ID (Identification)

Step 1. Name of Urban Forestry Unit

On this sheet, enter information about your community's urban forestry program and management. Some of this information is printed out on various summary and database forms.



I. Program Identification

Step 1. Name of Urban Forestry Unit

Enter Name of City or Community	*City of Santa Clarita*
Name of Department or Division	*Urban Forestry Division*
Street Address	*1414 S. Mullberry Street*
City	*Santa Clarita*
State	*California*
Zip	*93014*
Phone Number	
FAX Number	

Name of Program Administrator	
Phone Number	
Email	

Name of Database Manager	
Phone Number	
Email	

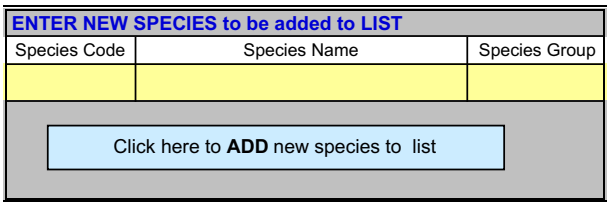
Sheet 2 SETUP

Step 2. Species Code, Species Name, and Species Group

In this step, each species must be assigned three fields of information, 1) a numeric species code, 2) a text species name, and, 3) a species group number. The result will look like the next chart.

Species Code	Species List	Species Group
1	Acacia baileyana	2
2	Acacia longifolia	2
3	Acacia melanoxylon	2
4	Acer buergeranum	6
5	Acer negundo	6
6	Acer palmatum	13

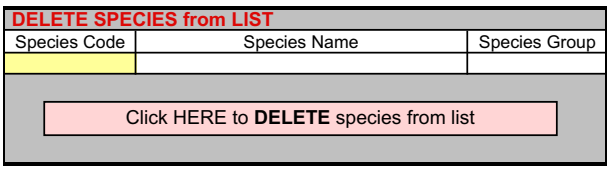
You must use the following sections on the spreadsheet to enter or delete this information.



ENTER NEW SPECIES to be added to LIST

Species Code	Species Name	Species Group

Click here to **ADD** new species to list



DELETE SPECIES from LIST

Species Code	Species Name	Species Group

Click HERE to **DELETE** species from list

1. To enter Species Code information, only use positive integers from 1-500. It is best to use consecutive numbers, if possible. Set up your numbering scheme before entering numbers.

2. The Species Name is normally the scientific name, however, the program will accept any text in this field.

3. Species Group: Only use positive integers from 1-50. However, the species group number must be one that has or will be defined in Step 3 before using the program. Note that this information for Species Groups 1-19 already comes with the program (Step 3).

The group number selected should be of the group name that most closely resembles the tree type, species and branching characteristics. For example, Canary Island pine would be best matched with Group 3, the Monterey pine group. Successful matching of a species to the group name requires knowledge of the tree characteristics in the inventory, as well as those of the groups listed

in Step 3. To assist the user, there are 3 photos (small, medium, and large) of each of the first 15 species shown in Step 3 in Pillsbury *et al* (1998).

To delete a species, only the species code is needed. Be certain to Save your changes frequently.

Sheet 2 SETUP

Step 3. Enter New Volume Equations

The program comes with 21 built-in species groups and their volume equations. It is possible to add more as equations become available. This requires very careful work and a good understanding of the process so the program will run correctly.

1. In this step the user may name a new species group. It must be assigned the next available species group number. Group numbers must stay in consecutive, contiguous order.

2. Each new species group must have Local Volume Equation coefficients entered into the correct field. Optionally, Standard Volume Equation coefficients may be entered. They are desirable because Standard Volume Equations are more accurate than Local Volume Equations.

   Local and Standard Volume equations are of the following form:

   Local Volume Equation: $V = aD^b$

   Standard Volume Equation: $V = aD^bH^c$

   where V is total tree volume in cubic feet computed from Smalian's formula, D is diameter at breast height (dbh) in inches, and H is total height in feet. Coefficients a, b, and c are provided by the author of the equation.

   IMPORTANT: A Local Volume equation MUST be entered to ensure the program will run properly.

   CUFIM selects the Standard Volume equation if tree heights have been entered, otherwise, the Local Volume equation is used.

3. The seven columns headed by the title "*Percent of tree volume by stem dia. class*" have been determined for groups 1-19 from various studies by the authors where these values were actually determined. The values for groups 20-49 would have to come from new studies. Or, the user could select the values from species groups 1-15 that most closely matched the new

Volume Equation Coefficients for Species Groups

Species used for Species Group	Species Group	Local vol coef.		Standard vol. Coef.			Percent of tree volume by stem dia class						
		a	b	a	b	c	<4	4-8	8-12	12-16	16-20	>20	Total
	-1	0	0	0	0	0							
Blue Gum	1	0.055113	2.436970	0.003089	2.151822	0.835731	4.0	10.0	10.0	11.0	11.0	54.0	100.0
Acacia	2	0.048490	2.347250	0.014058	2.186485	0.467357	9.7	21.0	17.5	15.5	12.0	24.3	100.0
Monterey Pine	3	0.019874	2.666079	0.005325	2.226808	0.668993	6.0	14.0	9.0	11.0	9.0	51.0	100.0
Monterey Cypress	4	0.035598	2.495263	0.005764	2.260353	0.630129	5.0	11.0	8.0	8.0	9.0	59.0	100.0
Carob	5	0.066256	2.128861	0.008573	1.795854	0.926668	11.0	27.0	18.0	8.0	10.0	26.0	100.0
Camphor	6	0.031449	2.534660	0.009817	2.134803	0.634042	12.9	27.7	23.1	13.6	10.6	12.1	100.0
Chinese Elm	7	0.028530	2.639347	0.010456	2.324812	0.493171	12.8	25.1	19.8	21.6	14.0	6.7	100.0
Holly Oak	8	0.025169	2.607285	0.004307	1.821580	1.062691	17.3	33.9	19.8	17.0	9.1	2.9	100.0
Jacaranda	9	0.036147	2.486248	0.011312	2.185780	0.548045	12.8	25.3	24.9	20.5	9.6	6.9	100.0
Liquid Ambar	10	0.030684	2.560469	0.011773	2.315815	0.415711	13.1	21.1	23.0	19.6	14.7	8.5	100.0
Modesto Ash	11	0.022227	2.633462	0.001287	1.762964	1.427822	12.0	28.0	21.0	14.0	9.0	16.0	100.0
Sawleaf Zelkova	12	0.021472	2.674757	0.006664	2.363178	0.551904	28.5	27.5	15.0	9.0	6.0	14.0	100.0
Chinese Pistache	13	0.019003	2.808625	0.002921	2.191572	0.943669	27.0	32.0	18.0	11.0	11.0	1.0	100.0
Southern Magnolia	14	0.022744	2.622015	0.004486	2.070408	0.845627	18.0	23.0	15.0	15.0	14.0	15.0	100.0
London Plane	15	0.025170	2.673578	0.010425	2.436420	0.391682	14.0	22.0	15.0	14.0	14.0	21.0	100.0
Sycamore	16	0.075051	2.335230	0.050119	2.177385	0.212477	12.8	25.3	24.9	20.5	9.6	6.9	100.0
Redwood	17	0.044697	2.390837	0.002438	1.694874	1.098957	6.0	14.0	9.0	11.0	9.0	51.0	100.0
Coast Live Oak	18	0.042542	2.466100	0.006526	2.319580	0.625280	18.0	23.0	15.0	15.0	14.0	15.0	100.0
Tanoak	19	0.119906	2.028700	0.004748	1.933890	0.819070	13.1	21.1	23.0	19.6	14.7	8.5	100.0
	20												

species group being entered. Group 50 is reserved for non-volume trees like Palms.

If you are entering this information, make sure the percentages for each stem diameter size totals 100% in the last column. This data is used to express a trees' volume by stem size class. From a product development standpoint, this information is valuable.

Sheet 2 SETUP

Step 4. Advice on Setting up Measurement Units

The settings discussed in this section are for information only. Selecting or not selecting choices does not affect the program and none of these choices are used in any way. However, it is important to set and stick with a measurement system. This step allows the user to see the outcome of various choices.

Choices that need to be made before a new inventory is undertaken are discussed below. If a database already exists, these choices should be set anyhow, as long as they follow these guidelines.

A. Diameter measurements

1. Precision of tree diameter measurements. Precision is the closeness of the measurement unit, *e.g.,* the diameter is measured to the nearest 0.1", 0.5", 1", or 2". Ideally, it should not exceed 1". The smaller the precision number, the better the estimate of tree volume. Once selected, all trees should be measured to the desired precision.

2. Smallest diameter class to be measured in the field. The smallest diameter class must be selected and maintained throughout the inventory. This value should be equal to or larger than the diameter precision value selected in A1 above. Examples are: 1.0", 2.0", 4.0", 6.0". Ideally, it would be 1.0".

3. All diameter classes must be of the same interval. Do NOT make diameter or height classes of unequal intervals. An example of diameter classes that should NOT be used is: <6", 6-9", 9-18", 18-24", >24.

Do NOT allow the largest diameter or height class to be open ended. For example, do NOT have a diameter class of >24". It will not be possible to obtain accurate estimates of volume with this type of class. An example of a proper system for a precision of 2.0" follows. The largest dia class to be used is 80".

Dia Class	Interval
2	1.0 - 2.9
4	3.0 - 4.9
6	5.0 - 6.9
⋮	⋮
80	79.0 - 80.9

B. Height measurements

1. Precision of tree height measurements. Examples of height precision would be to the nearest 1', 5', 10', etc. Ideally it would be, 1' or 5'. The smaller the precision number the better the estimate of tree volume. Once selected, all trees should be measured to the desired precision.

2. Smallest height class to be measured in the field. The smallest height class must be selected and maintained throughout the inventory. This value should be equal to or larger than the height precision value selected in B1 above. Examples are: 5', 10' and 15'. Ideally, it would not exceed 10'.

3. All eight classes must be of the same interval. As discussed before, do NOT make diameter or height classes of unequal intervals. An example of height classes that should NOT be used is: <20, 20-30', 30-40', 40-50', >50'.

Do NOT allow the largest diameter or height class to be open ended. For example, do NOT have a height class of >50'. It will not be possible to obtain accurate estimates of volume with this type of class. An example of a proper system for a height precision of 5' follows. The tallest tree expected is 150'.

Ht Class	Interval
5	2.5 - 7.5
10	7.5 - 12.5
15	12.5 - 17.5
⋮	⋮
150	147.5 - 152.5

Once the "rules" of measurement are determined, they must be written down and passed on to new employees. And most importantly, they must always be followed.

Appendix B makes recommendations concerning the information that might be collected and the level of importance it has in urban forestry planning.

Sheet 3 DATABASE

Step 5. Create and Maintain Tree Database Inventory

Note: A section devoted to transferring an existing database into this program can be found in Appendix A.

This discussion starts with the database itself, and then addresses how to add, change and delete records. The database is comprised of 25 columns, 15 which are built-in, and 10 which are user-defined. See chart at bottom of pages 10 and 11.

Column 1: The Sequence Number is the number that CUFIM assigns the tree record. It is always consecutive, from 1 to n. This number is used extensively by CUFIM.

Column 2: Tree Record number is the number the user gives the tree. This may be any size but must be a positive integer. These numbers are normally consecutive, but over time small gaps may occur due to deletions.

Column 3: Species code value is based on the species list in Step 2 on the SETUP sheet. It is automatically calculated.

Column 4: Removal code is an integer automatically calculated by one of the options on the REMOVAL sheet (to be discussed later). It is always a value of 1 if the tree is to be removed, and blank if the tree is not to be removed.

Column 5: Species Name is based on Step 2 from the SETUP sheet. It is automatically calculated.

Column 6: The Species Group number is based on Step 2 from the SETUP sheet. It is automatically calculated.

Column 7: Tree dbh is in inches, and is a value measured in the field. The format should follow the advice provided in Step 4 under SETUP.

Column 8: Tree Height is total height in feet, and is a value measured in the field. The format should follow the advice provided in Step 4 under SETUP.

Column 9: Volume is total tree volume in cubic feet. It is calculated based on the coefficients entered in Step 3 under SETUP. If Standard Volume coefficients are available, they will be used, otherwise, the Local Volume coefficients are used.

Columns 10-15: Branch volumes, sometimes called stem volume, are shown by 6 size classes. These values are obtained or updated by clicking the yellow "*Click here to Update Cubic Feet of Tree volume by Branch Dia Size*" rectangle. Allow 1-4 minutes for computation depending on computer speed and size of database. The source of these values is Pillsbury, Reimer and Thompson (1998). Only update after you finish adding, changing or deleting data records.

Headers above Columns 1-16 show:

Col 1	maximum number in database
Cols 2-8	count, or the number of items in each column
Cols 9-15	sum of the values in each column in the database
Col 16	the sum of all branch sizes in percent and cubic feet.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Max Number	Count	Count	Count	Count	Count	Count	Count
22,221	22,221	22,221	1,104	22,221	22,221	22,221	22,211

Sort by Seq	Sort	Sort			Sort	Sort	
Sorted by Dbh Sequence No.	Tree Record	Species Code	Removal	Species Name	Species Group	Tree DBH (in)	Tree Ht (ft)
1	32	152		Pyrus calleryana	12	6.0	8
2	50	119		Pinus canariensis	3	6.0	8
3	51	119		Pinus canariensis	3	6.0	8
4	53	191		Washingtonia robusta	50	6.0	8

The database is "balanced" when columns 1-3, and 5-8 all show the same value. If they don't agree, search the database (or hard copy) to find errors or blanks. These errors should be fixed using the Change or Delete functions on this sheet. The only exception is Total Height (column 8) which could be less if some heights were not measured or entered.

The three main functions in this section are subroutines to Enter (or add) a new record, Change an existing record, and to Delete an unwanted record.

The "Enter or Add a New Record" Function

To enter or add a new record, use the blue section. The next sequence number and tree record number are automatically generated.

ENTER NEW RECORD in Tree Inventory

Information	New Data
NEXT Seq. No.	22222
NEXT Tree Record	40167
Species Code	
Tree Dbh (inches)	
Tree Ht (ft)	
Address	
Dist fr Street (ft)	
Sidewalk Damage (L,M,H)	
Variable 4	
Variable 5	
Variable 6	
Variable 7	
Variable 8	
Variable 9	
Variable 10	

Species Name

User Defined Variables

<--Enter Variable names here.
For example:

Change this...
Variable 1

...to this
Sidewalk Damage (L, M, H)

Click here to **ADD** New Record to Inventory

The user must enter species code, and dbh in inches. Optionally, the user may also enter total height in feet, and information about user defined variables 1-10.

User defined variables can be numeric or text. See Appendix B for further discussion. Enter the name of the variable and the acceptable units of measure. Keep names as short as possible. For example:

Numeric example: Dist fr Street (ft)

Text example: Sidewalk Damage (L,M,H). You would have to develop criteria to distinguish among Low to High levels of damage.

To add this information to the inventory database, click the blue box at the bottom, titled "****Click here to ADD New Record to Inventory****."

The "Change a Record" Function

Follow these steps to change an existing record.

1. Type the tree Sequence Number in the green section's yellow cell. A sequence number can be obtained in two simple ways. First, print a hard copy, which includes sequence numbers. Secondly, split the screen and scroll down to the desired tree and read the sequence number from column 1.
2. Check data about that tree in the *"Current Data"* column to be sure this is the correct tree to be modified.
3. Enter the new data in yellow cells under the column titled "*Change Data to*."
4. Click on green box at bottom, titled "****Click here to CHANGE Existing Record in Inventory****."

(9) %, cf	(10) %, cf	(11) %, cf	(12) %, cf	(13) %, cf	(14) %, cf	(15) %, cf	(16) %, cf
100.0	29.0	16.0	12.8	11.8	10.5	19.9	100.0
964,241	280,074	153,961	123,105	113,522	101,403	192,176	964,241

	Volume by Branch Diameter Size						
Volume (cf)	Vol in <4"	Vol in 4-8	Vol in 8-12	Vol in 12-16	Vol in 16-20	Vol in >20	
1.4	0.3	0.7	0.5	0.4	0.2	0.4	
1.1	13.9	21.9	14.9	13.9	13.9	20.9	
1.1	13.9	21.9	14.9	13.9	13.9	20.9	
0.0	2.2	5.1	3.8	2.5	1.6	2.9	

In the example below, tree sequence number 1 is a Pyrus calleryana, 6.0" dbh, 7.5' tall located 4.5' from the street. The results of these changes are shown at bottom of this page.

CHANGE EXISTING RECORD in Tree Inventory

Information	Current Data	Change Data To
Sequence No.	1	
Tree Record No.	32	
Species Code	152	
Removal Code	0	
Species Name	Pyrus calleryana	
Tree Dbh (inches)	6	
Tree Ht (ft)	7.5	
Address		2570 Elm St.
Dist fr Street (ft)		4.5
Sidewalk Damage (L,M,H)		M
Variable 4		
Variable 5		
Variable 6		
Variable 7		
Variable 8		
Variable 9		
Variable 10		

Click here to **CHANGE** Existing Record in Inventory

The "Delete a Record" Function

Deleting records is a two step process.

1. Type the tree Sequence Number in the red section's yellow cell.
2. Check data in next column to be sure this is the correct tree to be deleted from the database. Be careful, there is no undo option.
3. Then click the box labeled "*1. Click here to DELETE Record from Inventory*"
4. Repeat steps 1-3 as often as needed.
5. When all deletions are completed, you MUST click on the cell labeled "*2. You MUST Click here to UPDATE All Records after Deletions are done*." It will take 15-30 seconds to reorder the database.

DELETE RECORD from Tree Inventory

Information	Delete Tree No.	Data to be Deleted
Sequence No.	18454	18454
Tree Record No.	1. Click here to **DELETE** Record from Inventory	37920
Species Code		108
Removal Code		0
Species Name		Morus alba
Tree Dbh (inches)		18.0
Tree Ht (ft)		37.5
Address		
Dist fr Street (ft)		
Sidewalk Damage (L,M,H)		
Variable 4		
Variable 5		
Variable 6		
Variable 7		
Variable 8		
Variable 9		
Variable 10		

2. You **MUST** Click here to **UPDATE** All Records after Deletions are done

Print the Database

1. Click and hold on the "*Print Options*" drop box. Two options are displayed.
   a) "*Species and Volume Data (Cols 1-15). Total pages = 445*"
   b) "*User Defined Variables (Cols 17-26). Total pages = 445*"

   The total number of pages will vary depending on the database size. Be sure to have an adequate supply of paper available.

When your database has 30 or more records (trees), your screen may be too small to view them. It will be useful to split the screen horizontally and scroll to the area of interest in order to see the effect of additions, changes and deletions.

(17)	(18)	(19)	(20)	(21)
Count	Count	Count	Count	Count
1	1	1	0	0

Address	Dist fr Street (ft)	Sidewalk Damage (L,M,H)	Variable 4	Variable 5
2570 Elm St.	4.5	M		

Sheet 4 STATS

Step 6. Generate Basic Statistics for Tree Inventory

1. Part A, "*Tree Inventory Statistics*," is always current.
2. To update "*B. Number of Trees per DBH Class*" and "*C. Volume by DBH Class*", click the yellow boxes.
3. Click the print box for a hard copy.
4. It is possible that the total number of trees and the total volume shown below differ slightly from the same numbers shown in the header of the DATABASE sheet. This difference is because trees over 90" are not included below.

See example below.

IV. Generate Basic Tree Inventory Statistics

Step 6. Calculate Basic Statistics for Tree Inventory

A. Click the Yellow boxes to generate up-to-date statistics.
B. Click the Green Print box to Print all Tables.

Print Statistics

A. Tree Inventory Statistics

Statistic	Current Data	Max Allowed
Species		
Number of Species =	201	500
Number of Species Groups =	21	50
Number of Trees in Database =	22,221	50,000
Diameter		**Std Deviation**
Average Dbh (inches) =	12.9	6.6
Minimum Dbh (inches) =	6.0	
Maximum Dbh (inches) =	60.0	
Height		
Average Tree Height (ft) =	20.2	13.7
Minimum Tree Height (ft) =	6.0	
Maximum Tree Height (ft) =	90.0	
Volume		
Average Tree Volume (cf) =	28.0	83.0
Minimum Tree Volume (cf) =	-	
Maximum Tree Volume (cf) =	2,760.0	

B. Number of Trees per DBH Class (Click to update)

C. Volume by DBH Class (Click to update)

No. of Dbh Classes =	**10**	**Total Volume of Trees =**	**964,241 cu ft**
Total Number of Trees =	**22,221**		

Dbh	Lower	Upper	No. of Trees in Dbh Class	Tree Volume in Dbh Class
6	2.00	8.99	7,075	40,262
12	9.00	14.99	8,170	190,019
18	15.00	20.99	4,614	245,016
24	21.00	26.99	1,662	211,081
30	27.00	32.99	465	113,181
36	33.00	38.99	166	92,354
42	39.00	44.99	35	27,303
48	45.00	50.99	26	39,002
54	51.00	56.99	7	5,335
60	57.00	62.99	1	687
66	63.00	68.99		
72	69.00	74.99		
78	75.00	80.99		
84	81.00	86.99		
90	87.00	92.99		
96				

V. How to Estimate Volume and Value of Tree Removals

SECTION B. TREE REMOVAL VOLUME AND VALUE CALCULATIONS.

This part of the guide describes advanced options and management tools for the urban forester.

The main objective for the following sheets is to calculate, analyze and evaluate information for trees that would be removed in a given year.

Sheet 5 OUTPUT PARAMETERS

Step 7. Range of Tree Diameters to be Included in Volume Calculation of Removal Trees

This section is used to limit the size of tree (dbh) that will be removed, which in effect, limits the size of tree to be included in the analysis.

Two options are presented. The user may select both the minimum and the maximum tree diameter to be included, or just one of the options.

Minimum Diameter choices:

a) Select "None" to include the smallest dbh (2")

b) Select 2, 4, 6, 8,…up to 50" to exclude all trees below the selected diameter

Maximum Diameter choices:

a) Select "None" to include the largest dbh in the database.

b) Select 20, 22, 24,…up to 80" to exclude all trees above the selected diameter.

If the value of Min>Max, an error message is displayed until the relationship is reversed.

Examples:

1. If it seems feasible to exclude diameters less than 10" because they don't provide volume that can be used at this time, set Min to 10, Max to None.
2. If trees over 60" dbh are valued for historic reasons and should not be included in the analysis, set Max = 60".
3. To calculate the volume and value of trees between 20 and 40 inches, set Min = 20", Max = 40"
4. To calculate volume and value of trees 10-20 inches and 40-50 inches, you will need to make two "runs" using Step 7 and Step 10 (discussed later). For run #1, set Min = 10, Max = 20. For run #2, set Min = 40, Max = 50.

Sheet 5 OUTPUT PARAMETERS

Step 8. Indicate Species to be Excluded from Volume Calculation of Removal Trees

1. Enter the Species Code for any species you want excluded from Removal volume and value analysis. A maximum of 50 species may be excluded. See the bottom of page 15 and the example below.
2. The Species Code must be a valid code. If an invalid code is entered, an error message appears. This must be corrected before continuing.
3. Codes entered are of trees that will NOT be Included in removal volume and value calculations.

Example:

Step 7 Dia Limits	Step 8 Excluded Trees	Step 9 Included Trees	Result
Min = 20 Max = None	a) 23 b) 71 c) 99	(blank)	The volume and value of species 23, 71 and 99 that are less than 20" will be excluded from removal volume and value calculations. All other trees will be part of the analysis.

Sheet 5 OUTPUT PARAMETERS

Step 9. Indicate Only the Species to be Included in Volume Calculation of Removal Trees

1. NOTE: The user cannot enter codes in BOTH Steps 8 and 9. Doing so will cause multiple error messages to appear. They will remain until entries only appear in Step 8, Step 9, or neither.
2. The Species Code must be a valid code. If an invalid code is entered, an error message appears. This must be corrected before continuing.
3. Codes entered in Step 9 are the ONLY species that will be used in the removal volume and value calculations.
4. The more trees entered in either Step 8 or Step 9, the slower the program will run.

Examples:

Step 7 Dia Limits	Step 8 Excluded Trees	Step 9 Included Trees	Result
Min = 10 Max = 60	(blank)	a) 155	Quercus agrifolia trees (species code 155) that are 10-60" in diameter will be considered for removal, all other species will be excluded.

Step 7 Dia Limits	Step 8 Excluded Trees	Step 9 Included Trees	Result
Min = 20 Max = 50	a) 37 b) 84 c) 85	a) 143 b) 202	No result. Error messages are displayed. CUFIM does not allow trees to be excluded and included simultaneously.

Sheet 6 REMOVAL

Step 10. Estimating the Annual Volume of Tree Removal by Randomly Selecting Trees, or by Field Marking Trees.

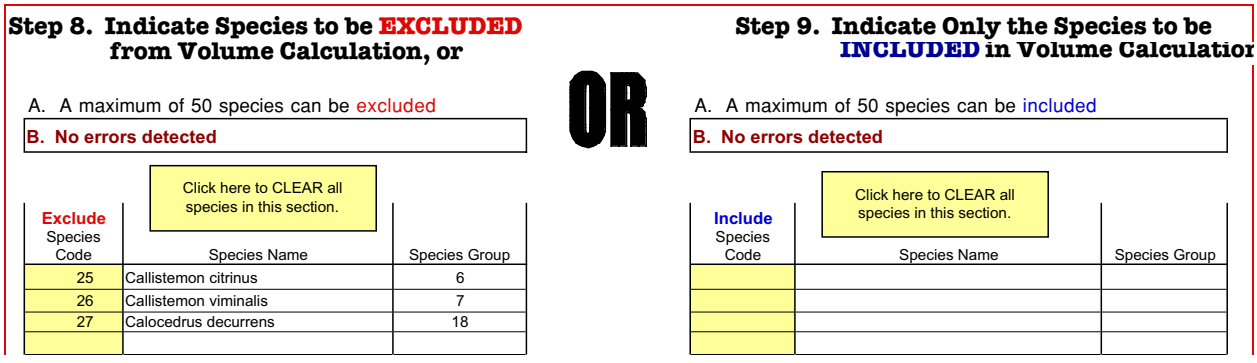
This section, along with the OUTPUT PARAMETERS sheet (Steps 7-9), define how trees are selected for removal. Two methods of tree removal are discussed, Method 1 and Method 2.

This process allows the user to project the volumes that can reasonable expected or anticipated to be lost each year. Trees selected from Method 1 are based on the percentage of trees expected to be removed each year, and are not the actual trees to be removed.

The process for analyzing and evaluating the volume and value of trees removed each year can be accomplished through either of these methods.

1. Method 1 — Estimations Based on Removal Percentages. Due to budget constraints, timing or other reasons, it may be impractical to conduct the field surveys discussed in Method 2 below. In addition, there are a number of reasons why only a projected level of volume and value may be desirable.

   a. From a general planning and logistics standpoint, it is necessary to determine the labor force size, equipment needed, and to establish a schedule for tree removal. It would be valuable to have an estimate of the magnitude of the task before removal begins.



b. These estimates would also be valuable from a budget and policy perspective. Urban foresters may be asked to project expenses and incomes into the next several years. This information can be estimated here, providing planning offices, elected officials, and perhaps even voters requisite data needed to set policy and determine the budget for urban forestry operations.

c. It would be normal for the percentage of removal trees to vary from year to year. CUFIM allows the user to conduct a number of computer "runs" to obtain multiple estimates of projected volume and value for removal trees. This can be done by using several different percentages of expected tree removal in order to bracket the expected removal volumes and values. This approach would provide a "low", "average", and "high" value for consideration.

In Method 1, the user sets the expected percent of tree loss per year. Also, there are two variations available to the user, called Method 1A and Method 1B. Based on settings from either Method 1A or 1B, CUFIM computes the expected volume and value of removal trees.

2. Method 2 — Calculations based on Field Measurements. Under this scenario, the urban forester actually marks trees on the ground for removal. Their volume and value is then calculated through a series of computations discussed in the following steps. To use Method 2, extensive field measurements and assessment data are required. This approach will provide a very accurate estimation of removal volume and value.

If field surveys are planned, follow these steps to enter the data in the spreadsheet.

a. In the field, record tree record number, tree location, and Species Code for each removal tree.

b. In CUFIM select the DATABASE sheet and locate Column 4, Removal.

c. Scroll down until the tree record number is found, then check the species code and address to verify this is the correct tree.

d. Type the number "1" (without quotes) in the Removal column. Note that the cells are not yellow. This is the only time you are permitted to type in non-yellow cells.

e. Continue this process until all trees are entered.

f. It is VERY IMPORTANT that you DO NOT run the Random Number Generator. Doing so will delete all your entries. Instead, proceed directly to Sheet 7, Step 11a.

The remainder of this section discusses the details of how Methods 1A and 1B work.

Method 1A: Estimating Volume by Estimating the PERCENT of ALL Trees to be Removed Next Year.

There are three parts to this section, A, B, and C (see circled area on page 18).

1. Part A: On the sheet titled REMOVAL, Click Box A.

2. If selections on the OUTPUT PARAMETERS sheet (Steps 7-9) have not been made, they should be done before continuing with this section.

3. Part B: Select a value for "*Percent of All Trees to be Removed*." This is based on data from previous years, and/or knowledge about the coming year.

4. Part C: Select Choice 1, 2 or 3.

   a. If diameter limits were not set in Step 7, then check Choice 1, "*No Dia. Limits*" in Column 6.

   b. If diameter limits were made in Step 7, check Choice 2 or 3. Choice 2 (Column 7) shows the number of trees to be included after diameter limits were imposed. This number (and percentage) could be significantly less than the desired value (selected

in Part B), however, if the number is satisfactory, then Choice 2 should be checked.

c. On the other hand, if the number of removal trees (and percent) in Choice 2 is considered too low, try Choice 3 (Column 8). CUFIM attempts to increase the number of removal trees in each diameter class by an amount, that when summed, provides the desired percent initially selected in Part B. For various reasons however, this may or may not be possible.

(1) If it <u>is possible</u>, this will be evident by observing the "*Total Removed*" and "*Percent of Inventory*" values for Choice 3 (column 8). They will be the same as for Choice 1 (column 6).

(2) If it <u>is not possible</u>, the "*Total Removed*" and "*Percent of Inventory*" values will still be lower than Choice 1, but higher than Choice 2. If these values are acceptable, check Choice 3.

(3) If neither Choice 2 or 3 are acceptable, you may decide to revise the initial "*Percent of All Trees to be Removed*" in Part B, or relax the restrictions imposed on diameter in Step 7.

5. Calculating the Actual Number of Trees for removal using the Random Number Generator.

The purpose of the random number generator is to randomly select the number of trees that will be removed in each diameter class. For the example on page 18, this would be 8 trees from the 42" class (see column 6).

a. The number of trees it will attempt to select is based on your choice in Part C, that is, Choice 1, 2 or 3. For example, if 8 trees are needed in the 42" diameter class (out of a total of 35 trees in that class; column 4) the random number generator will randomly select 8 trees from this group.

b. Regardless of whether Choice 1, 2 or 3 is selected, the <u>actual</u> number of trees "marked" for removal (column 9) may be lower, and depending on user restrictions considerably lower, than the desired number. If restrictions are too limiting, there simply won't be enough trees left in unrestricted dbh classes to make up the difference.

Your choices for increasing the number of removal trees are essentially the same as those discussed in 4.c(3) above.

c. The suggested approach is:

(1) Initiate several computer runs with the percent selected (in Part B) that you believe is most likely to occur, and then,

(2) Bracket the percentage used in Part B by selecting a smaller, and then a higher percentage. Conduct several runs for both of these.

d. Figure 2, "*Number of Trees Removed*" shows both the Total Number of trees to be removed to achieve the desired percent (blue dashed line, from column 6), and the actual number that were marked for removal by the random number generator (red line, from column 9). This provides a visual picture of desired versus actual for the computer run.

The first Fig. 2 (Figure 2a) on page 19, is for the example on page 18; the second Fig. 2 (Figure 2b) is for the case when the minimum diameter to be included in the analysis was 20".

e. Note that entering Species Codes in Step 8 or Step 9 does not affect the number of trees selected for removal. If CUFIM generates a random number of a tree that was Excluded (Step 8), or is not Included (Step 9), it immediately generates a new number and continues doing so until it finds a number that matches an included species.

Method 1A: Estimating Volume by Estimating the PERCENT of ALL Trees to be Removed Next Year.

A. Check Box A. ☒ Box A.

B. Select the Percent of All Trees to be Removed. 2 %

C. Select Choice 1, 2 or 3 >>>

Clear All Choices--}

	Choice 1	Choice 2	Choice 3
	No Dia. Limits	With Dia Limits	Max. No. (w/dia limits)
	☒		

This percentage is distributed across all tree diameters as shown in the graph below.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			Click to **Update** this column	Total Removed = 444 Percent of Inventory = 2.00		444 2.00%	444 2.00%	444 2.00%
Dbh	Lower	Upper	No. of Trees in Dbh Class	Adj. % Chance of Tree Removal*	Number of Trees to be Removed	Attempted No. of Trees Left to be Removed	Attempted No. of Trees to be Removed	Actual No. of Trees Removed
6	2.00	8.99	7,075	0.6	43	43	43	43
12	9.00	14.99	8,170	0.7	61	61	61	61
18	15.00	20.99	4,614	2.9	132	132	132	132
24	21.00	26.99	1,662	6.6	109	109	109	109
30	27.00	32.99	465	11.4	53	53	53	53
36	33.00	38.99	166	16.9	28	28	28	28
42	39.00	44.99	35	22.9	8	8	8	8
48	45.00	50.99	26	30.8	8	8	8	8
54	51.00	56.99	7	28.6	2	2	2	2
60	57.00	62.99	1	0.0	0	0	0	
66	63.00	68.99						
72	69.00	74.99						
78	75.00	80.99						
84	81.00	86.99						
90	87.00	92.99						
96			22,221					

*Percent needed in each dbh class to equal the desired overall percent of trees to be removed.

Adjustment Ratio = 1.00

Random Number Generator

Click here to generate Removal Trees based on selections made in Part A.

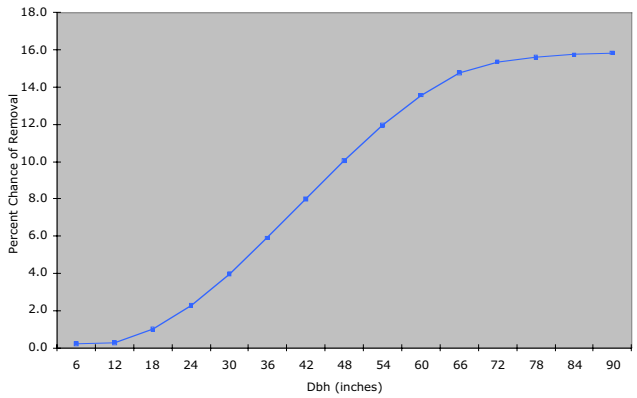
Be patient, depending on options selected and computer speed, this operation can take 2 to 4 minutes

How are the Number of Removal Trees per dbh Class Computed?

a. This example is when no diameter restrictions are placed on the calculation. The overall number of removal trees is calculated based on the overall percent of trees expected to be removed. (Example shown above: 22,221 trees in the database x 2% expected loss (from Part B) = 444 removal trees).

b. These 444 trees are distributed among the diameter classes based on the percent chance of tree loss shown in Figure 1 below (*Percent Chance of Tree Removal*). This graph is based on an equation that recognizes that larger trees are more likely to be removed than smaller ones, and are therefore, assigned a higher percent chance of removal.

Fig. 1. Percent Chance of Tree Removal



c. For example, in the 42" dbh class, it is expected that 8% of the trees would be lost in a given year. In the 42" dbh class there are 35 trees (column 4) x 8% = 2.79 trees to be marked for removal. This is done for each diameter class and summed. In this example, the total for all diameter classes is 153.85 trees.

d. The number of trees per diameter class are proportionally decreased or increased, by a multiplier, to automatically provide the number of trees necessary to attain the desired overall percent (selected in Part B). They are displayed in column 6. The multiplier, in this case 2.886, is calculated from the number of removal trees (from (a) above) ÷ the total number of trees calculated by (b) above for all diameter classes, or 444 ÷ 153.85 = 2.886.

e. In this example, the number of removal trees in the 42" diameter class is increased from 2.79 to 8 trees to be marked for removal (2.886 x 2.79 = 8.06 or 8 trees).

f. Last, the number of trees/dbh class in column 6 is divided by the total number in the corresponding dbh class (column 4) to arrive at the "*Adjusted Percent Chance of Tree Removal*" shown in column 5. For our 42" diameter class example, 8 ÷ 35 = 22.9%.

3. Additional Notes on Method 1A

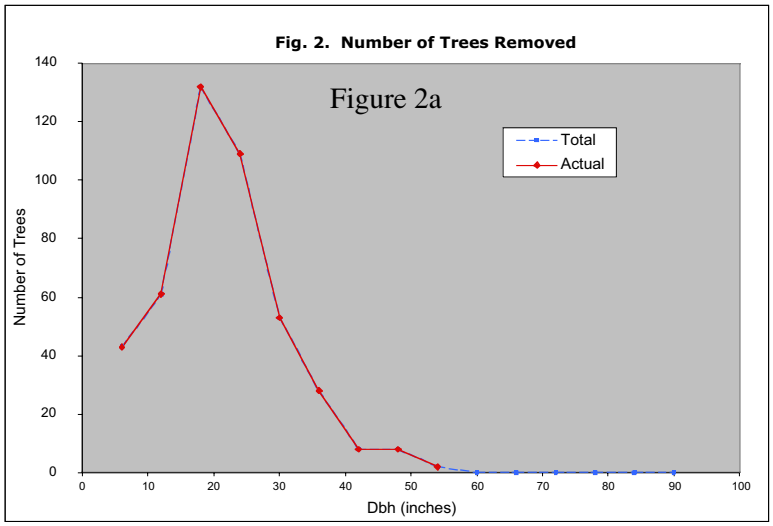
   a. If the range of acceptable diameters, set by min and max in Step 7, is too narrow, most, if not all trees in the remaining classes will be selected for removal. This may invalidate any analysis and projection of volume removal and value. Some practice with setting output parameters is needed, as well as caution when interpreting results.

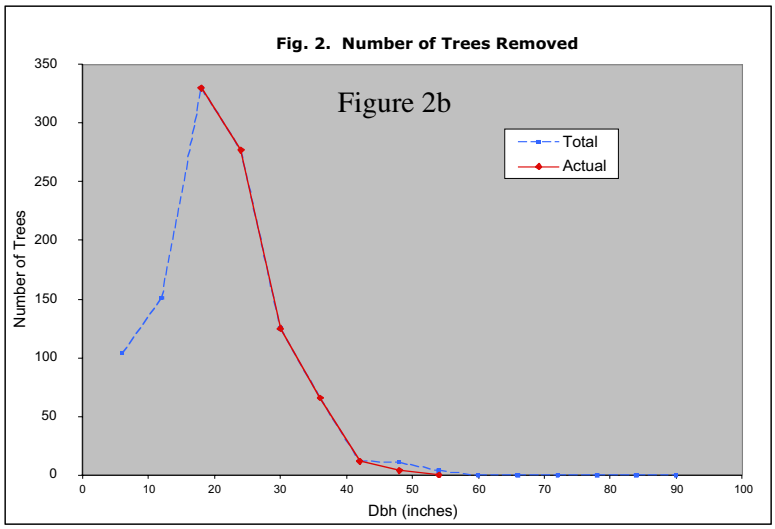
   b. Note that CUFIM uses 6" diameter classes to determine tree removal volume and value. This is too wide an interval for field measurements, but is fine for estimating removal, since trees of all diameters in the class have an equal chance of being selected.

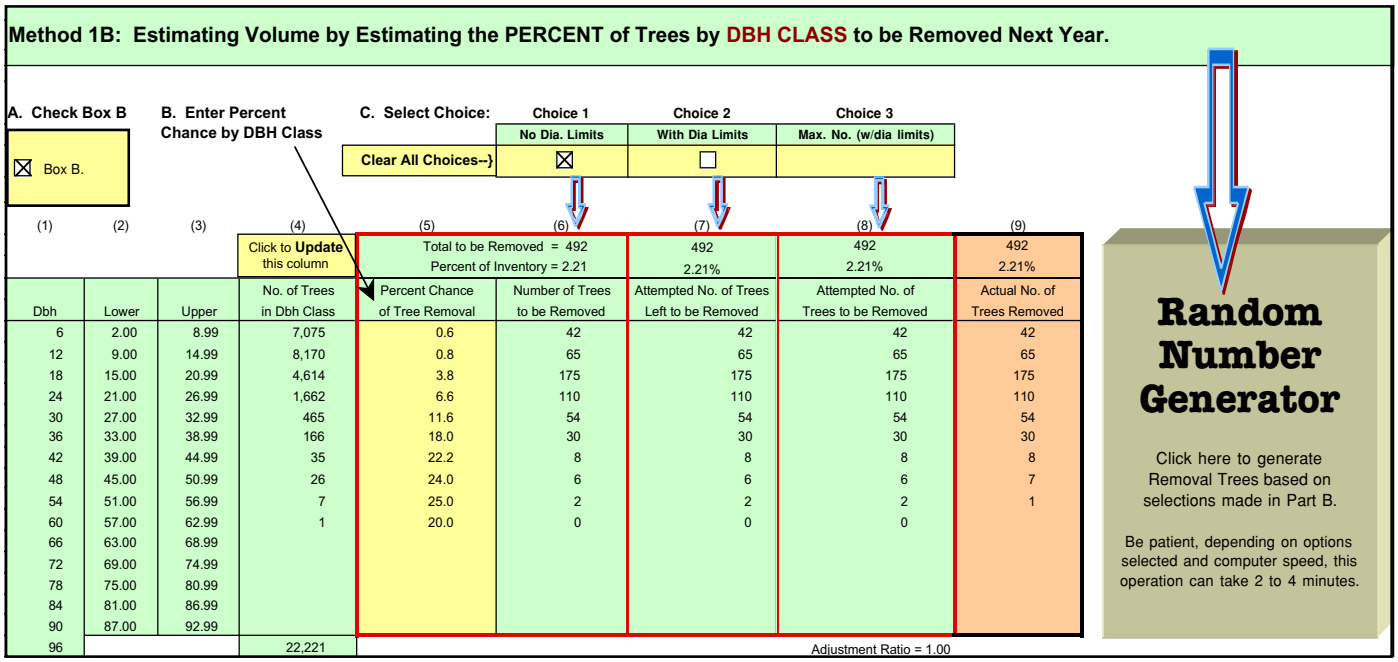
   c. Running the Random Number Generator does not provide an immediate response. A huge number of calculations are being performed. The operation can take from 3-5 minutes depending on computer speed, size of database, and output settings of diameter limitations, and exclusions or inclusions of species. However, about 10 "runs" could be made in an hour from your database providing valuable information about your urban forest that could not be obtained any other way.

   d. As seen in Figure 1, the probability of removal varies from about 0.2% for 6" dbh trees up to about 16% for 90" trees. These values were derived from a community's urban forest database of 22,221 trees conditioned to provide 2% of the total number of trees when summed over all dbh classes, and to represent the normal S-shaped curve. Two percent was selected based on the average age of an urban tree before removal. If a community's trees are all ages from 1-50 years, then each year about 2% will be removed (1/50 x 100). Two percent is also a number used by some urban foresters in California.

In addition to this approach used in Method 1A, a user-defined approach is available in Method 1B.







Method 1B: Estimating Volume by Estimating the PERCENT of Trees by DBH CLASS to be Removed Next Year.

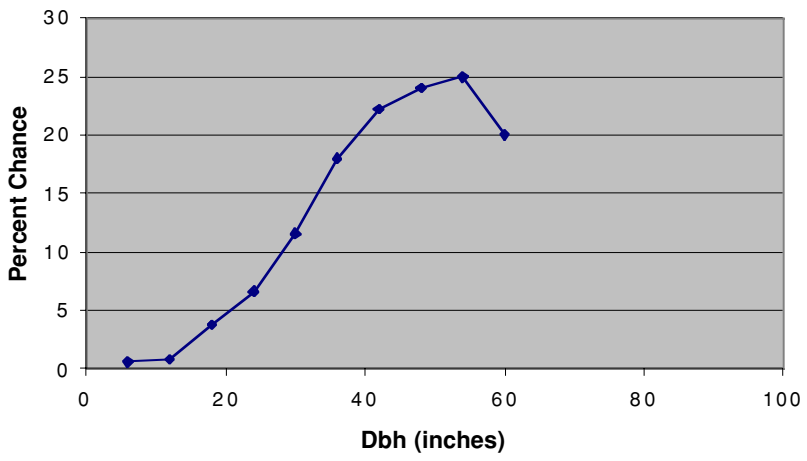
The purpose of Method 1B is to allow the urban forester the flexibility of entering their own estimates of loss by diameter class. This requires accurate knowledge and a good understanding of the urban forest structure and composition.

Deselect Box A and clear choices for Method 1A before beginning Method 1B. Read Method 1A prior to working with 1B. There are three parts to this section.

1. Part A: On the sheet titled REMOVAL, Click Box B.
2. Part B: The procedure used in Method 1B is the same as for Method 1A except for the approach used to determine Percent Chance of Tree Removal (column 5). Values for Method 1A were based on a statistical model, the values for Method 1B are based on the knowledge and experience of the user. The cells in column 5 are yellow, allowing the user to estimate the percent chance of removal per size class based on data from prior years, and expected conditions for next year.

The values selected in column 5 are graphically shown in Figure 3, at the bottom of the screen ("*Percent Chance of Removal*"). Although the graph is set for a maximum of 30%, higher percentage values will work, but they won't

Fig. 3. Percent Chance of Tree Removal



show on the figure. This is interactive and the user can see the trend change in Figure 3 as values in Column 5 are entered.

3. Part C: Select Choice 1, 2 or 3.

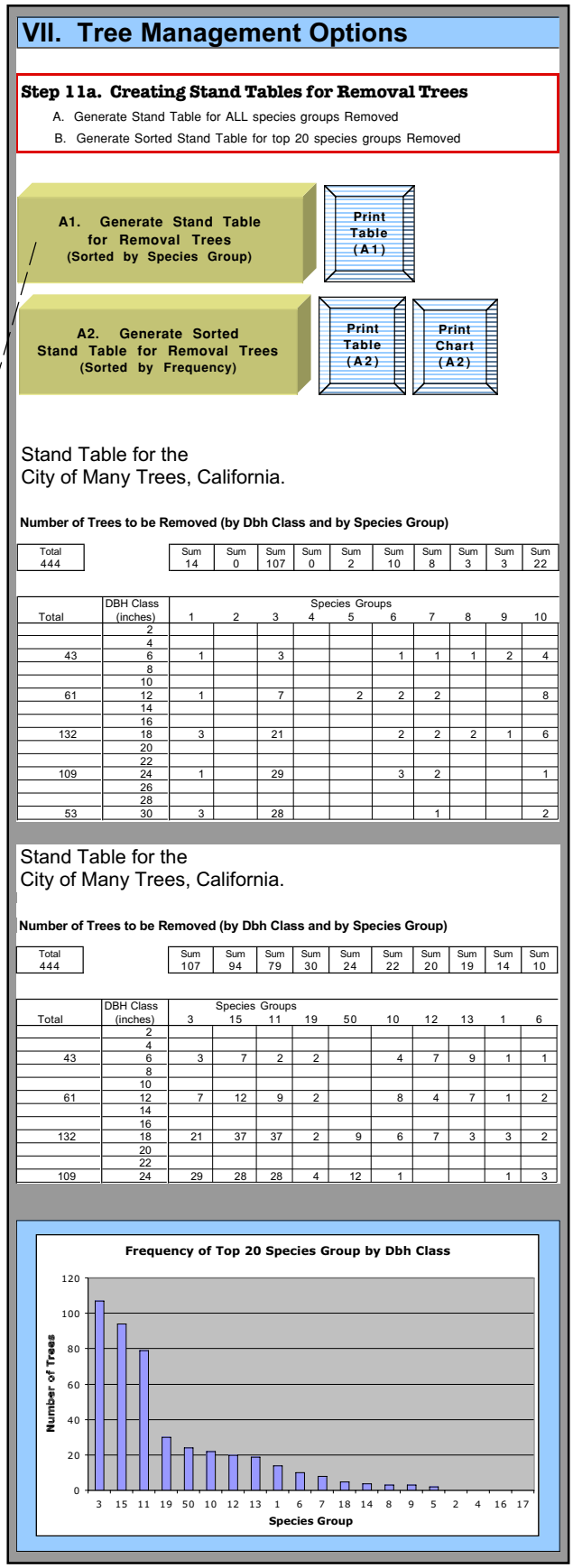
   The discussion presented in Method 1A, Part C, applies here as well.

Sheet 7 MGT OPTIONS

Step 11a. Creating Stand Tables for Removal Trees.

Stand Tables are tables that show the number of trees by species group, and by diameter class. The diameter class interval is set at 2 inches.

1. Click Box A1 to generate a stand table for removal trees "marked" by Method 1 or 2 on the REMOVAL sheet. A stand table summarizes the number of trees by dbh class and species group that would be removed.
2. If Removal Method 1A or 1B was used, the tree numbers in the stand table are those selected by the random number generator and are estimated or projected values. However, if these are trees that were marked in the field and entered in the database according to Method 2, these numbers represent real data.
3. Select "*Print Table (A1)*" to print the table generated by Box A1.
4. Normally the majority of trees to be removed will fall in only a few of the species groups. Clicking on box A2 will sort the top 20 species groups by the frequency of trees each contains. Thus the groups that most contribute to the total number of trees to be removed can easily be detected.
5. Select "*Print Table (A2)*" to print the table generated by Box A2.



6. To print a chart (full page) of the information summarized from box A2, click on "Print Chart (A2)."

7. If you wish to clear all tables, click on "*Clear Stand & Stock Tables*."

Sheet 7 MGT OPTIONS

Step 12a. Creating Stock Tables for Removal Trees

Stock Tables are tables that show the total volume of trees by species group, and by diameter class. The diameter class interval is fixed at 2 inches.

1. Select Box A1 to generate a stock table for removal trees "marked" by Method 1 or 2 on the REMOVAL sheet. The table summarizes the volume of trees by dbh class and species group that would be removed.

2. If Removal Method 1A or 1B was used, the tree volumes in the stock table are those selected by the random number generator and are estimated or projected values. However, if these are trees that were marked in the field and entered in the database according to Method 2, these volumes represent real data.

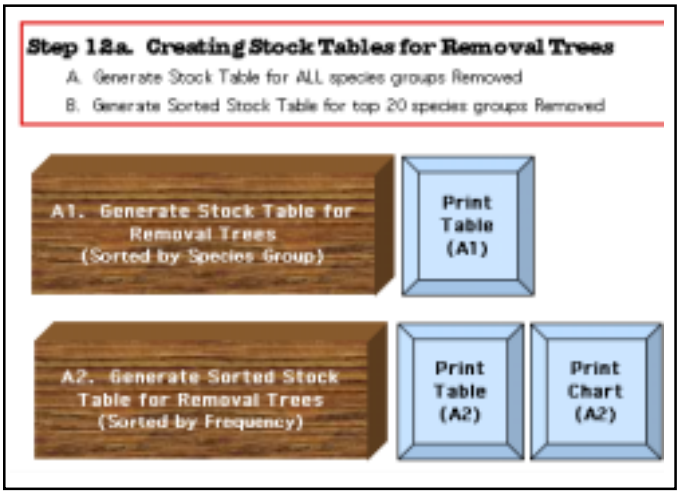
3. Select "*Print Table (A1)*" to these print results.

4. Normally the majority of the volume to be removed will fall in only a few of the species groups. Clicking on box A2 will sort the top 20 species groups by the amount of volume each species group contains (see below). Thus the groups that most contribute to the total volume to be removed can easily be detected.

5. Select "*Print Table (A2)*" to print these results.

6. To print a chart (full page) of the information summarized from box A2, click on "*Print Chart (A2)*."

7. If you wish to clear all tables, click on "*Clear Stand & Stock Tables*."



Stock Table for the
City of Many Trees, California.

Volume of Trees to be Removed (by Dbh Class and by Species Group)

Total		Sum	Sum	Sum	Sum	Sum	Sum	Sum
73,394		2,660	0	13,360	0	27	1,941	559

Total		DBH Class (inches)	Species Groups 1	2	3	4	5	6	7
		2							
		4							
170		6	2		3			2	2
		8							
		10							
2,129		12	3		78		27	28	36
		14							
		16							
5,919		18	120		852			105	113
		20							
		22							
13,561		24	79		2,362			259	238

NOTE: If you are working on Removal trees, skip Steps 11b and 12 b. Steps 11b and 12b are stand-alone steps and are not part of the tree removal process. Use these steps to create stand and stock tables for the entire database. The products generated from these steps are the same as shown for Steps 11a and 12a.

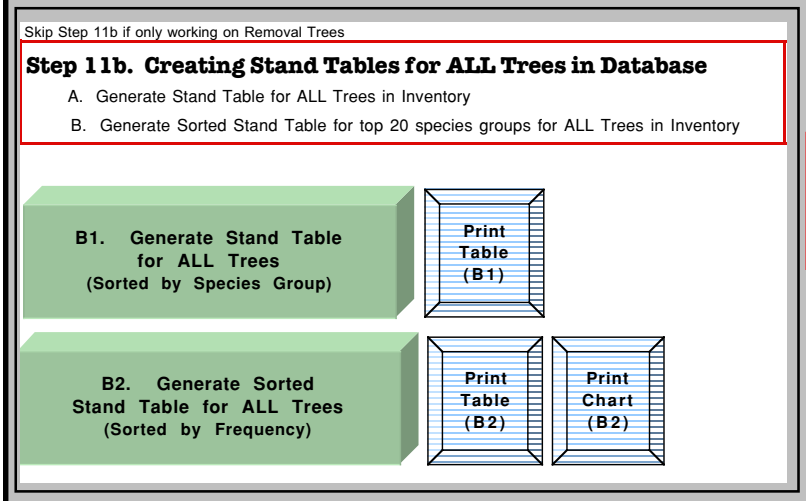
Urban foresters can use stand and stock tables to gain understanding of the structure and composition of the urban forest and the distribution of volume. They provide a concise summary of the number of trees and volume by species and diameter class, and give a picture of the overall forest.

Sheet 7 MGT OPTIONS

Step 11b. Creating Stand Tables for ALL Trees in Database

This step is NOT part of the Removal procedure, and MUST be skipped if you are currently working on Removal trees. This step includes ALL records of ALL species and ALL diameter classes, regardless of settings made in steps 7-10. This provides an excellent picture of the urban forest, but is not designed to evaluate removal trees.

1. Clicking box B1 allows the user to develop a Stand Table for ALL trees in the inventory database.
2. Clicking B2 sorts, by species group, the top 20 groups (groups having the greatest number of trees).
3. Print boxes allow for hard copies of tables generated from boxes (B1 and B2), and for a print out of a chart derived from box B2.

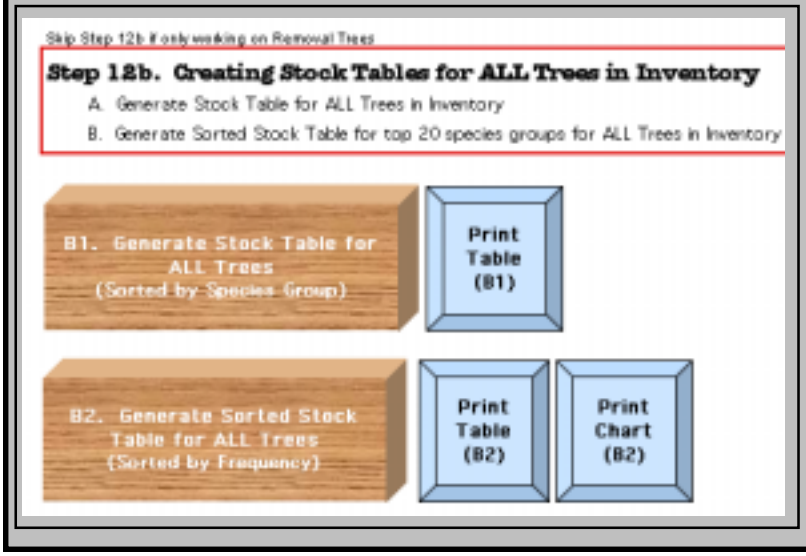


Sheet 7 MGT OPTIONS

Step 12b. Creating Stock Tables for ALL Trees in Inventory

This step is NOT part of the Removal procedure, and MUST be skipped if you are currently working on Removal trees. This step includes ALL records of ALL species and ALL diameter classes, regardless of settings made in steps 7-10. This provides an excellent picture of the urban forest, but is not designed to evaluate removal trees.

1. Clicking box B1 allows the user to develop a Stock Table for ALL trees in the inventory database.
2. Clicking Box B2 sorts, by species group, the top 20 groups (groups having the greatest volume).
3. Print boxes allow for hard copies of tables generated from boxes (B1 and B2), and for a print out of a chart derived from box B2.



Sheet 8 VALUATION

Step 13. Preliminary Valuation - Same Value Method

The purpose of establishing value for urban trees is the primary objective of this project. Without a known value, urban foresters cannot plan budgets or have a say in policy considerations.

The "Same Value Method" is used for situations when the unit value of removed volume can be considered equal regardless of species group, species, or tree size. It is not necessary to calculate the stand and stock tables prior to calculating value in this step, however, doing so provides valuable management information to the user. The volume and value data that are obtained from this section are based on restrictions imposed in Steps 7-9 and on Choices 1, 2 or 3 checked on the REMOVAL sheet under Method 1A or 1B.

1. Create or Update the species list by clicking on the box titled "*Click here to Create Current Species List, and Species Groups*."
2. Check box for Method 1 to create and setup new spreadsheet columns.
3. Select the value you believe can be charged to buyers either in units of dollars/cubic foot, or dollars/standard cord. One standard cord equals 128 cubic feet of space stacked with split or branch wood (equivalent to 4' x 4' x 8'). The actual volume of wood in this space is approximately 62 cubic feet.
4. The user has two sort options. Click on either of the 2 yellow column headers, "*Species Code*" or "*Value by Species ($)*" to sort these columns, respectively.
5. Click on the Print box to print results.
6. Note, that Step 13 can be run even if Step 14 has been completed, and visa versa.

VIII. Preliminary Valuation

Step 13. Preliminary Valuation - Same Value Method (tables showing the value of

A. Create List of Current Species

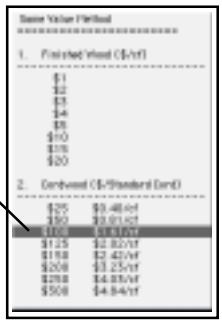
B. Check Method 1 box. Select value from drop box list

Click here to Create Current Species List, and Species Groups

Method 1 -- Assign Same Value to All Trees

$100 $1.61/cf

Click on Yellow headings to SORT



Preliminary Estimate of Tree Removal Value for the City of Many Trees, California.

			Totals =	73,394	$118,165
Species Code	Species List	Species Group	Same Value Method ($/cf)	Volume by Species (cf)	Value by Species ($)
155	Quercus agrifolia	19	$1.61	32,595	$52,478
121	Pinus halepensia	3	$1.61	6,640	$10,691
169	Schinus molle	19	$1.61	5,220	$8,404
132	Platanus X acerifolia	15	$1.61	4,035	$6,497
124	Pinus pinea	3	$1.61	2,777	$4,471
78	Fraxinus velutina	11	$1.61	2,035	$3,276
133	Platanus racemosa	15	$1.61	1,998	$3,216
32	Cedrus deodara	18	$1.61	1,710	$2,753
183	Ulmus americana	3	$1.61	1,673	$2,693
12	Alnus oregona	6	$1.61	1,548	$2,492
157	Quercus lobata	19	$1.61	1,260	$2,029
64	Eucalyptus rudis	1	$1.61	1,099	$1,770
185	Ulmus pumila	3	$1.61	1,036	$1,668
163	Robinia pseudoacacia	15	$1.61	1,023	$1,648
76	Fraxinus uhdei	11	$1.61	758	$1,221
108	Morus alba	12	$1.61	652	$1,050
118	Pinus brutia	3	$1.61	591	$952

Sheet 8 MGT OPTIONS

Step 14. Preliminary Valuation - Assign Value Method

The "Assign Value Method" is used for situations when the urban forester wishes to assign different values to the species. It is not necessary to calculate the stand and stock tables prior to calculating the value in this step, however, doing so provides valuable management information to the user. The volume and value data that are obtained from this section are based on restrictions imposed in Steps 7-9 and on Choices 1, 2 or 3 checked on the REMOVAL sheet under Method 1A or 1B.

1. Create or Update the species list by clicking on the box titled "*Click here to Create Current Species List, and Species Groups*," if not already done in Step 13.

2. Check box for Method 2.

3. Check box 2a or 2b. You cannot have both boxes selected. You must deselect the active box before selecting the other choice.

4. Box 2a — Assign Value by Species Group

   a. Selecting this box generates new columns, and sums the volume per species group.

   b. Next, you must enter the estimated value in units of dollars/cubic foot in the "*Value ($/cf)" column* (yellow cells).

   c. Results can be sorted by species group, volume, and total value by clicking on the appropriate yellow column headers.

   d. Click on the Print box to print results.

5. Box 2b — Assign Value by Tree Size

   a. Check box for Method 2, uncheck Box 2a, if not already done. Then check Box 2b.

   b. Selecting this box generates new columns and sums the volume into three dbh size classes.

   c. Next you must type the estimated value in units of dollars/cubic foot in the three "*Value by Size*" columns. If diameter restrictions were placed in Step 7 (OUTPUT PARAMETERS), or if certain species do not exist among one or more of the small, medium, or large diameter classes, no volume or value will show.

   d. Value may be sorted by clicking the "*Total Value ($)*" column header.

   e. Click on the Print box to print results.

6. Note, that Step 13 can be run even if Step 14 has been completed, and visa versa.

END OF PROGRAM NOTE

It should be noted again that using either Method 1A or 1B is a projection, and as such the trees "marked" for removal are not removed from the database.

This also true if Method 2 is used even if the trees are actually "marked" on the ground. If those trees are actually cut, the user needs to go into the database and actually delete the tree from the inventory list. The program does not automatically do that. To accomplish this:

a) Print the database, and then
b) Use the Delete function (Step 5) to delete the cut trees. The operation will remove the trees from the computer list.

Literature Cited

1. Pillsbury, N. H., J. L. Reimer, and R. P. Thompson. 1998. *Tree Volume Equations for Fifteen Urban Species in California*. Technical Report 7. Urban Forest Ecosystems Institute, Natural Resources Management Department, California Polytechnic State University, San Luis Obispo. 56 p.

2. Thompson, R., N. H. Pillsbury and J. Hanna. 1994. *The Elements of Sustainability in Urban Forestry*. Tech. Rept. No. 1. Urban Forest Ecosystems Institute, Cal Poly State University, San Luis Obispo. 56 p.

VIII. Preliminary Valuation

Step 14. Preliminary Valuation - Assign Value Method (tables that

A. Create List of Current Species

B. Check Method 2 box. Assign Value to Tree Species by Species Group, or, by Tree Si:

☐ **Method 2 -- Assign Value to Species Groups**

☐ 2a. Assign Value by Species Group

OR

☐ 2b. Assign Value by Tree Size

Assign values to Species Groups in the Yellow cells below.

Preliminary Estimate of Tree Removal Value for the City of Many Trees, California.

Totals =	73,394	$161,009

Species Group	Species used for Species Group	Value ($/cf)	Volume (cf)	Total Value ($)
19	Coast Live Oak	$3.00	39,615	$118,845
3	Monterey Pine	$1.00	13,360	$13,360
18	Redwood	$5.00	2,160	$10,800
11	Modesto Ash	$2.00	3,287	$6,573
15	London Plane	$0.50	7,405	$3,702
1	Blue Gum	$1.00	2,660	$2,660
6	Camphor	$1.00	1,941	$1,941
10	Liquid Ambar	$1.00	1,137	$1,137
12	Sawleaf Zelkova	$1.00	912	$912

Step 14. Preliminary Valuation - Assign Value Method (tables that show the value of trees to be removed)

A. Create List of Current Species

B. Check Method 2 box. Assign Value to Tree Species by Species Group, or, by Tree Size

☐ **Method 2 -- Assign Value to Species Groups**

☐ 2a. Assign Value by Species Group

OR

☐ 2b. Assign Value by Tree Size

Assign values to Species Groups in the Yellow cells below.

Preliminary Estimate of Tree Removal Value for the City of Many Trees, California.

			Total Volume =	73,394				
Totals =	170	21,609	51,616	$55	$14,620	$112,167	$126,842	

		Value by Size ($/cubic foot)			Volume by Size (cf)			Value by Size ($)			Total Value
Species Group	Species used for Species Group	Small <12"	Medium 12-24"	Large >24"	Small <12"	Medium 12-24"	Large >24"	Small <12"	Medium 12-24"	Large >24"	($)
19	Coast Live Oak	$0.50	$1.00	$2.00	90	5,940	33,585	$45	$5,940	$67,170	$73,155
3	Monterey Pine	$0.50	$2.00	$3.00	3	3,292	10,064	$2	$6,584	$30,193	$36,778
1	Blue Gum	$1.00	$2.00	$4.00	2	203	2,455	$2	$406	$9,821	$10,229
6	Camphor	$1.00	$2.00	$3.00	2	392	1,548	$2	$784	$4,643	$5,429
7	Chinese Elm	$1.00	$2.00	$2.00	2	387	170	$2	$774	$339	$1,116
8	Holly Oak	$1.00	$1.00	$1.00	3	78		$3	$78	$0	$82
5	Carob	$1.00	$2.00	$3.00		27		$0	$53	$0	$53

Appendix A

Instructions for Setup and Use

Instructions for CUFIM setup:

1. Set Excel memory as high as you can, even 100 mb or higher.
2. Close all other applications
3. Copy CUFIM to hard disk
4. Launch CUFIM
5. Make sure that Preferences/Calculation is set to automatic
6. Arrange desk top for maximum screen viewing space (hide formula bars, other tool bars, set screen resolution for optimum viewing, etc.).

Instructions for Using CUFIM:

1. Only enter data in yellow colored cells
2. Click on “Go to…” labels to move from sheet to sheet
3. Click on any box that starts with “Click here to…”
4. Click on any box that says “Print…” in it
5. Click on List Boxes, Combo Boxes and Check Boxes
6. Click on colored 3-D boxes or rectangles
7. Do not click on cells that aren’t on this list; program is not protected.

Appendix B. Outline of Data Needs and Recommendations

Different levels of data are needed for different management needs. The objective of acquiring and maintaining a city tree inventory will influence the amount and type of data needed. The following is organized from the lowest level of needs/management to the highest level.

Each higher level of data needs includes everything in the previous levels.

First level data (Minimum fields needed)

- Species codes (must include list of code descriptions).
- Diameter at Breast Height (precision of 5" classes or better – greater precision will result in better estimates of volume). All DBH classes must be of the same interval.
- Location of tree (address, lat/long, state plane, etc.) – May be obtained in several ways. For lower level management objectives an address will suffice. However for higher level management needs, it may be necessary to obtain data that can be accesses through a GIS.

Second level data needs

- Tree height – necessary for better estimates of volume and/or for power line considerations.
- Tree health – necessary to determine when trees will need to be removed. This can be in broad categories such as 1) tree is dead; 2) tree likely to die within one year; 3) tree likely to die within 5 years; 4) tree likely to die in 10 years (or within the return interval of the inventory); or 5) tree healthy.
- Age (year planted) – may be used as a surrogate for tree health. However, some indication of tree health will be a much better indication of when trees will need to be removed. Age will also be helpful for assessing the number (and thus volume) of trees that may need to be removed within in the same year (or few years). Age is absolutely necessary for long term planning of removal schedules.

Third level data needs

- GIS locations of trees – May be lat/long or state plane. Can be obtained by digitizing or with a GPS unit.

Other fields that may be useful in management.

- Crown information (height to crown base or crown radius).
- Ownership of tree.
- Right of way information.

Format

The format of the data should be generic enough that it may be opened in most applications and specifically in Microsoft Excel. Examples of acceptable format include all versions of Excel, database format (.dbf), text (delimited or fixed width (.txt, .csv, .prn); Microsoft Access, ArcView database, ArcGIS database and many others.

Appendix C. How to Import an Existing Database into CUFIM

This section discusses how to import an existing database into CUFIM. If you are a regular user of Excel, you will be able to follow these steps. If not, you may have to find an advanced user to assist you. There are many tricky details that can cause problems, but hopefully these tips and suggestions will ease the process.

Some of the operations discussed below can take several minutes to complete depending on your computer speed and size of database. If your database is over 10,000 records, you may want to break it into smaller groups.

It is recommended that before trying to import the data that you read the entire user's guide to understand how the program works. This knowledge will assist you with the entire process. In the guide, it specifically instructs the user to type only in yellow colored cells. Many operations discussed here will instruct you to work in non-yellow cells, however, after completion, you should avoid doing so.

The process described here will reformat the "look" of the database. You will have to reformat borders and cell contents as well as adjust row and column spacing as you proceed. Saving your work frequently and backing up your dataset is recommended.

1. There are a number of different tree inventory programs available. Most have a function that allows the user to export the data. Export as tab or csv delimited.

2. Use the Open command to import it into a blank Excel spreadsheet. Make sure the data looks the way you expected.

3. This is an opportunity to examine your data carefully and make sure that what your are importing is correct and complete. As a minimum make sure numbers and text are not mixed in the same column, except when needed (as in an address). Look for spelling errors and numbers that are obviously incorrect (negative numbers, values that are too large, etc.). Eliminate any records whose contents don't match expected data. The better the data being imported, the better the projections you will ultimately make. This process may even involve field checking to make sure the data are correct.

5. Preparing and Importing in Sheet 2, SETUP

   In this step you will assign (1) a species code, if needed, and, (2) a species group number to each tree. For species groups, see the discussion in user guide to assist this process; they are specially defined for this program. Code stumps and non-volume trees with a species group code of 50.

   If species codes came with the dataset, make sure the codes are values and not text. If they are text, insert a column to the right of the column of codes and in the first data row, say row 3, type: =VALUE(A3), and fill down to the bottom of the dataset. Select the data in the new column, copy and paste special values onto itself to eliminate the formula.

   Arrange the first three columns in the order shown on page 7 of the user's guide (species code, species name-normally the scientific name, and species group number). You may have to add the species group column.

   Next, sort the entire array of data by the species code column. Note, you may want to switch to manual calculation to save time.

6. Insert a new column to the right of the Species Group column and label it "Unique Sp. Code."

Type in a formula that, when filled down, will increment by 1 each time a row with a different species code is encountered. An example of how to do this is shown in the next table. Note that a different formula is in each of the first 3 data rows, but the formula in the 3rd row is filled down to the last data row.

You MUST Copy the cells in this column and Paste Special Values to eliminate the formulas. In the example below, select columns B-E, copy and paste into a new spreadsheet.

7. In the new spreadsheet, select the 4 columns of data (Species Code, Species Name, Species Group, Unique Sp. Code) excluding headers and blank lines, starting from upper left to lower right (use split screen). Tab three times to highlight the first cell in the 4th column (Unique Sp. Code). Click on the menu Data/ Sort, and make sure that the correct column (Unique Sp Code) is designated for sorting, and that "No header row" and Ascending are selected. Then, Sort, and Save.

8. With the screen split horizontally, scroll down until numbers in the Unique Sp Code column end. Select just the data (no headers) for the first three columns, down to and including the last row where the data in the Unique Sp Code column ends. Don't select cells in the Unique Sp Code column.

9. Copy the three columns (Species code-numeric, Species Name, and Species Group), and activate the CUFIM worksheet. On the SETUP sheet, click on cell B36, and paste. You may have to replace borders or format columns to your liking.

10. Preparing and Importing in Sheet 5, DATABASE.

    In the original exported dataset, arrange the following columns from left to right: (1) Tree Record Number (you may or may not need to create this), and (2) Species Code (the numeric version). Create sequence numbers in the Tree Record Number column if they are not already available. Use 1 through n (consecutive numbers). If you use an equation to create numbers in this column, then you MUST copy the column numbers, and paste special values back on top of them to eliminate the formula. Do not sort the data.

11. Copy the data in these two columns (no headers or blank lines), activate CUFIM and paste into cell P54 on the DATABASE sheet (the Tree Record column).

12. In the original exported dataset organize tree diameter and tree height (if available) in side-by-side columns in this order. If tree data is metric, convert to English units. If tree diameters or heights are given as a range, e.g., 4-8", use the mid-point. Make sure they are values, not text. Do not sort because when they are pasted into CUFIM they must match the data already placed there.

    Copy the diameter and height columns (no headers or blanks), and paste into cell U54 in the DATABASE sheet. Reformat borders and data appearance as needed.

    Click on the heading that begins in Column X52, titled "*Click here to Update Cubic Feet of Tree Volume by Branch Dia Size*" to generate data for these six columns.

	A	B	C	D	E
1	Species Code	Numeric Sp Code	Botanical	Species Group	Unique Sp code
2	1	=VALUE(A2)	Acacia baileyana	5	=B2
3	1	=VALUE(A3)	Acacia baileyana	3	=IF(B3=E2,"",B3)
4	1	=VALUE(A4)	Acacia baileyana	14	=IF(B4<>MAX($E$2:E3),B4,"")
5	1	=VALUE(A5)	Acacia baileyana	2	=IF(B5<>MAX($E$2:E4),B5,"")

13. Other Variables

    Your original dataset may have several other variables or descriptors that you want to keep, such as:

    Tree common name
    Tree location (address)
    Tree condition
    Sidewalk damage

    First set up the variable name in the "*To Enter a New Record*" section (cell P28 on the DATABASE sheet). For the example, replace the words "Variable 1" with "Condition (D, P, F, G)" for dead, poor, fair, good, or some other system. Do the same for other variables you want to keep, up to 10 variables total.

    Be sure the data you transfer is helpful in managing your urban forest before you import it.

    The names you give these variables will appear in cells AF53:AO53. These are the columns where you will paste the data.

    Follow the same procedures and cautions described earlier. You may have to widen some columns to see the cell content.

    The program comes with equations in the following cells in the DATABASE sheet.

    S54:S12000
    T54:T12000
    W54:W12000

    If your imported database is larger, fill down the equations. If it is smaller, delete the unused equations so the program will run faster. As more data is added, the equations are automatically generated.

14. After all data has been entered, notice that the Tree Sequence Number column is empty. First, click on the yellow "Sort" rectangle located above the Tree DBH data (column U). Then click on cell O54, and type the number 1. In cell O55, type: =O54+1. Fill this cell down to the last data record. Select all data in this column (O54 to the last record), Copy, and Paste Special Values back onto itself to eliminate the formulas.

15. Check the new database carefully and fully. Mistakes in transporting the data could cause huge errors. Test the database by:

    a) Calculating a few tree volumes, and comparing with the computed volume.
    b) Running the many routines on the DATABASE and remaining sheets.

    If errors occur, find the source and fix them. When you have thoroughly tested the database, you are ready to use it for an inventory database and for management decisions.

Andrea Tuttle
Director
California Department of Forestry and Fire Protection

Mary Nichols
Secretary for Resources
The Resources Agency

Gray Davis
Governor
State of California