



RURAL
TECHNOLOGY
INITIATIVE

The Landscape Management System (LMS): Emerging Technology for Integrated Forestry Applications

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Introduction

- Management of natural resources is becoming increasingly complex and the production and protection of those resources requires an increasing amount of analysis.
- Automated processes and software needs to be developed to help.

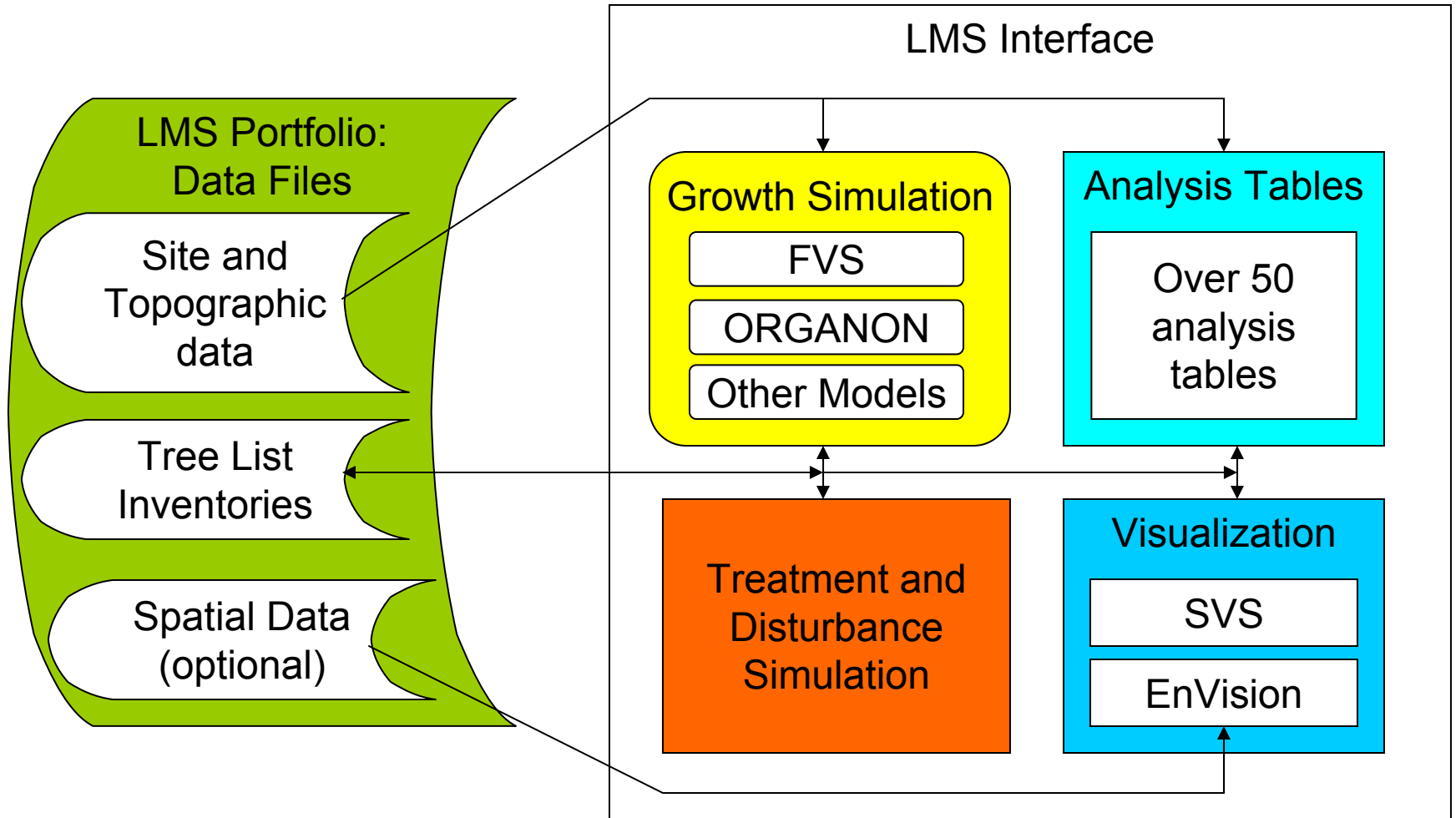


Description of LMS

- The Landscape Management System (LMS) integrates forest inventory, growth models, visualization, and analytical tools into a framework for evaluating stand- and landscape-level management alternatives.



LMS Components



LMS Data Requirements

- Stand level information
 - Site quality variables, age, area
- Tree inventory information
 - “tree list” (individual tree data with expansion factors),
Need Species, Diameter, and TPA, better to also have
Height and Crown ratio
- Spatial information (for landscape
visualization and spatial analysis)
 - Need elevation model (USGS DEM, SDTS, ESRI ASCII
Grid – converted to PC-Plans DTM format), map of
stand boundaries (ERSI shapefile or MOSS file), can
add other spatial features (roads, streams, trails, etc)



KC1

Add image of LMS...
Kevin Ceder, 6/18/2004

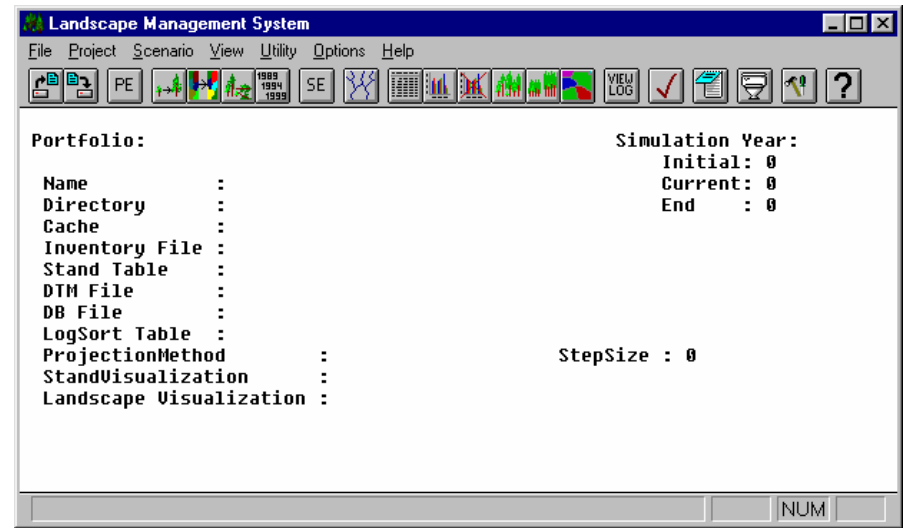
LMS Versions

- LMS 1.x – 1994-2000
- LMS 2.x – 2000-2005
 - LMS 2.0 – August 2000
 - LMS 2.0.42 – Feb 2001
 - LMS 2.0.45 – Jun 2002
 - ...
 - LMS 2.0.45 Release 9 – Nov/Dec 2004
 - LMS 2.0.45 Release 10 – Apr/May 2005
- LMS 3.0 – 2005-?
 - LMS 3.0 – Beta 3 – Apr 2005
 - LMS 3.0 – Beta 4 – May 2005



History of LMS - 1.x

- No longer available
- No longer supported
- People still like the buttons
- Awkward interface, limited flexibility and ability to enhance system
- Used many small files, filled disk
- Difficult to get data into system
- No feedback between components



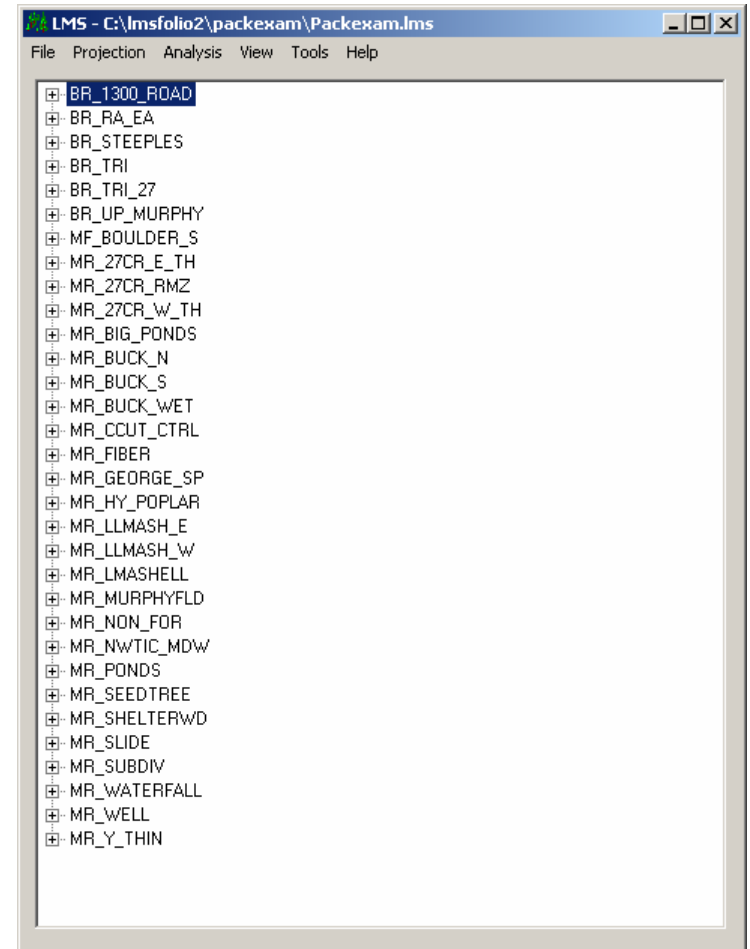
Programmed by Jim McCarter and Chris Nelson

★ Proof of concept that a system could be built to integrate tree list models, visualization, and analytical tools.



History of LMS - 2.x

- Available/Supported
- Includes FVS, Organon, SVS, EnVision
- Interface to Excel
- Inventory Wizard, Economatic, Carbon, Wildfile habitat, etc
- Limited size of portfolios
- Interface not intuitive enough
- Still difficult to get data in (Inventory Wizard developed to address this)
- Program enhancements required major modifications to software.
- Need more flexible simulation environment, enhanced treatment capabilities

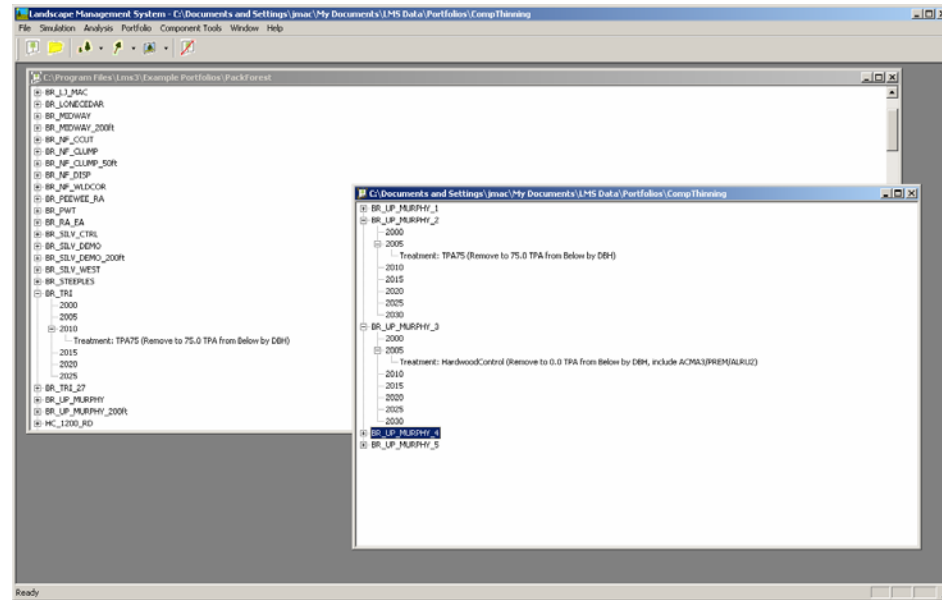


Programmed by Chris Nelson, Jim McCarter, Kevin Ceder, Jeff Connick



History of LMS - 3.0

- Available in Beta now
- Enhanced treatment capability
- Enhanced modeling capabilities
- Includes Organon, FVS, SVS, EnVision
- Interface to Excel, Access
- Larger portfolios
- Greater speed (~5 times faster)
- Expanded simulation capabilities
- Updated Inventory Wizard
- Improved integration capabilities (GIS, Web, etc)
- Enhanced bucking algorithm
- Understory modeling capabilities



Programmed by Chris Nelson, Jim McCarter, and Kevin Ceder



LMS 3.0 represents a new approach to the integration of the system components



LMS 3.0 - Design Goals

- Develop a more flexible, modular, robust, scaleable, and supportable system.
- Needs to handle larger landscapes and run significantly faster.
- Needs enhanced simulation capabilities
 - More growth models
 - Increased treatment options (more treatment variables and model specific treatments)
 - Pre- and post- model processing



More flexible, modular design

- All components are now Windows DLLs (data passed through memory)
- Component manager automatically “registers” components at runtime.
- Each component is responsible for its own configuration and any component specific data.
- Base components provide portfolio and inventory (tree, snag, understory) information.



More flexible, modular design

- Multiple interfaces are made much easier
 - Default, full featured interface
 - K-12 interface (simplified)
 - ArcGIS interface (mapping component in LMS and ArcGIS extension to provide an alternative interface)
 - Web interface
- LMS is now an automation server (can be run by other programs)



Faster Performance

- Native data formats are now all binary files
 - Provides better speed and security at the cost of some size
- Minimize file creation and activity
- Results in 5+ increase in performance
 - 100 stands growth one growth cycle in less than 16 seconds on 1.5Ghz computer
 - Pack Forest Example Portfolio (200 stands, 30 years):
 - ♦ LMS 2.x: 5 minutes 47 seconds
 - ♦ LSM 3.0: 1 minute 13 seconds

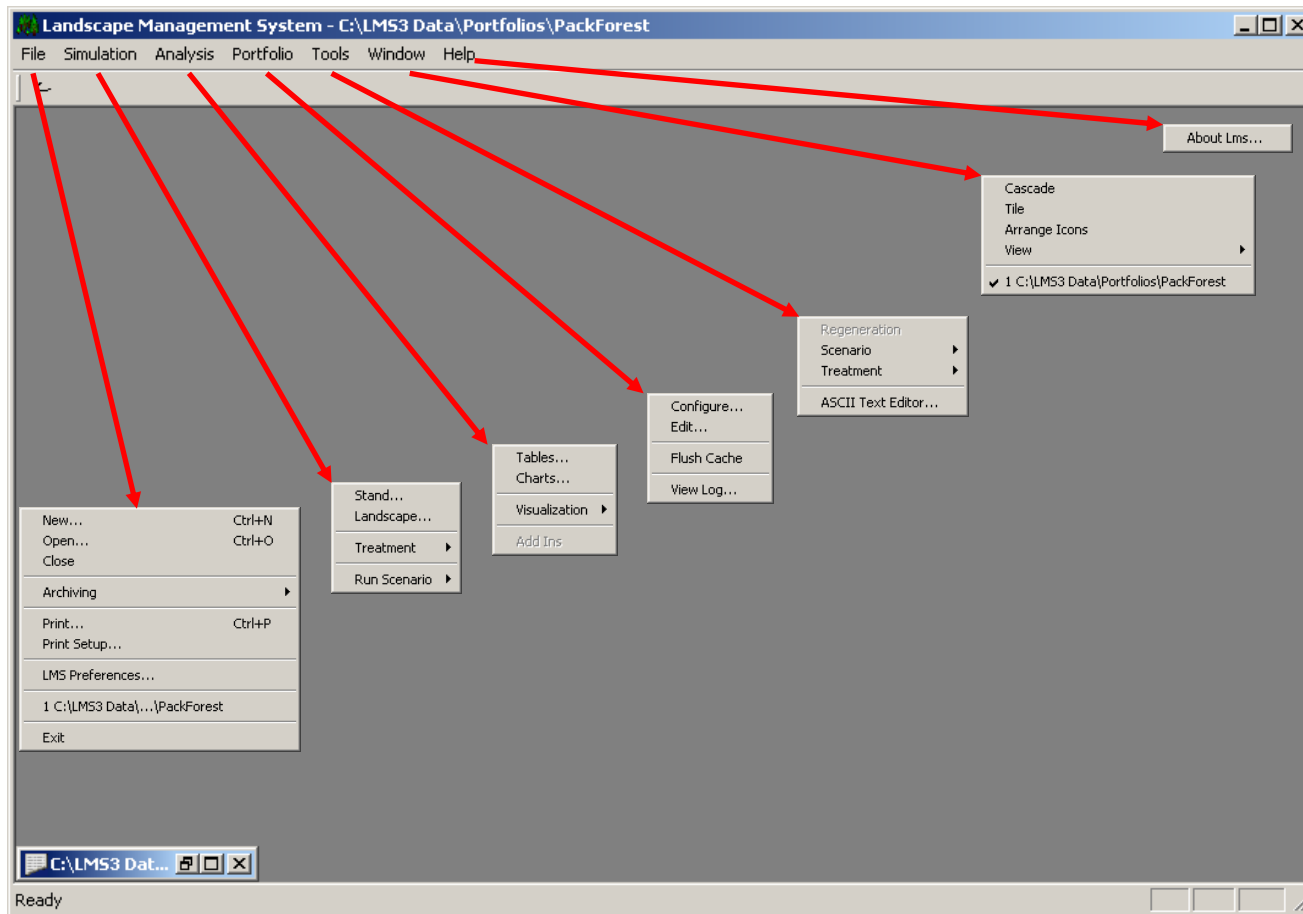


Enhanced Simulation Capabilities

- Can accommodate whole tree model
- Can support FVS pest extensions (Summer 2005)
- New models are linked by developing a model specific component DLL
- Pre- and post- model support also available
- Expanded treatment capability
 - Treat using many more variables
 - “Triggered” treatments (treat when stand reaches target condition)
 - Model specific treatment capabilities



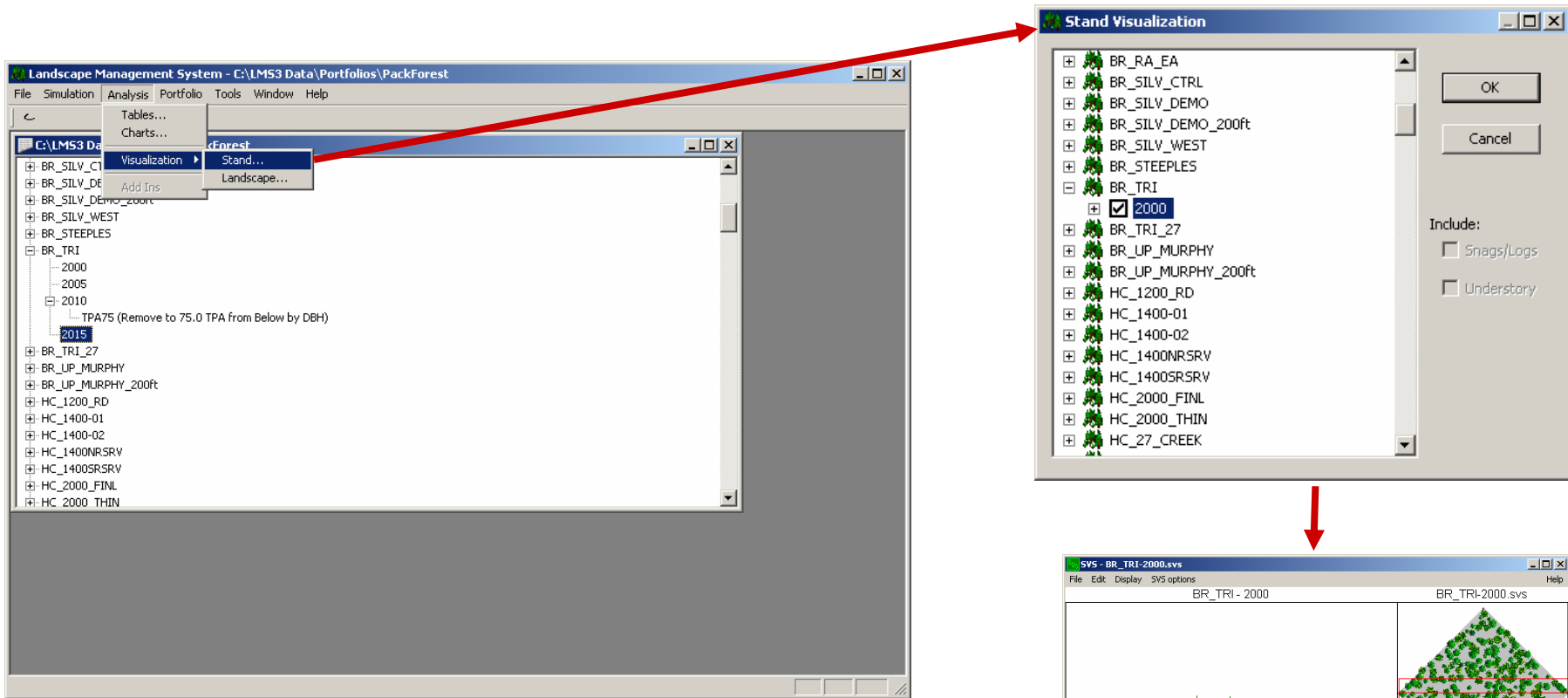
LMS Menus – Portfolio Open



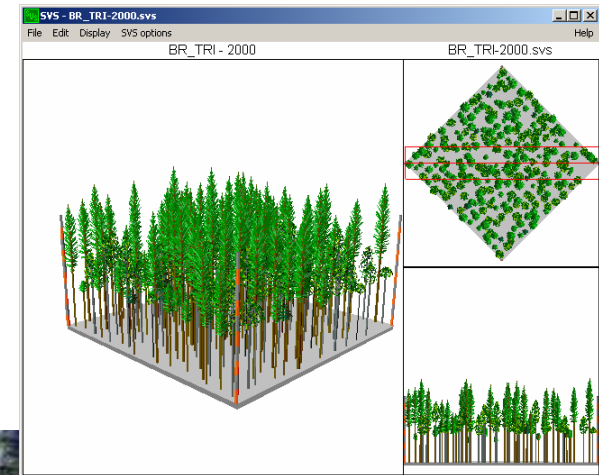
LMS 3.0 is a typical Windows program that operates using a series of menus and dialogs



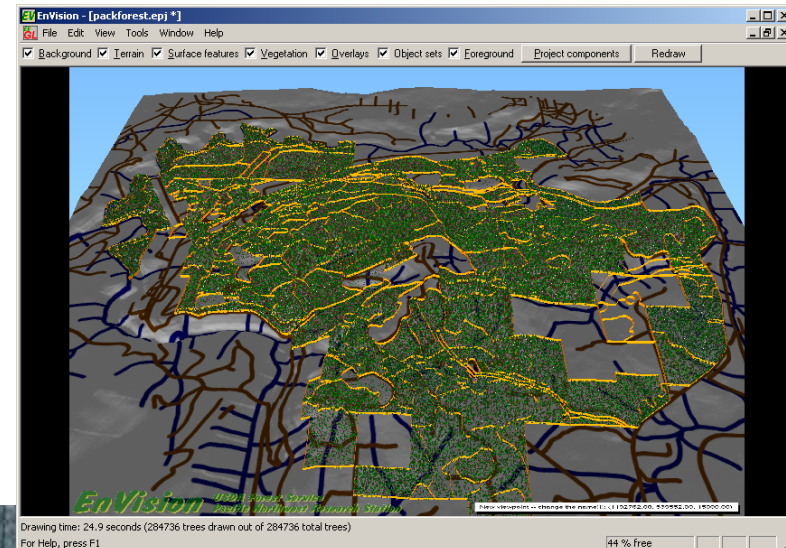
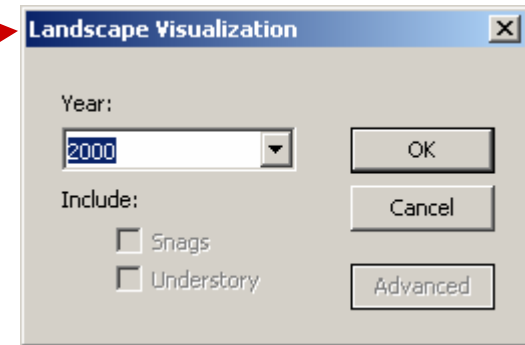
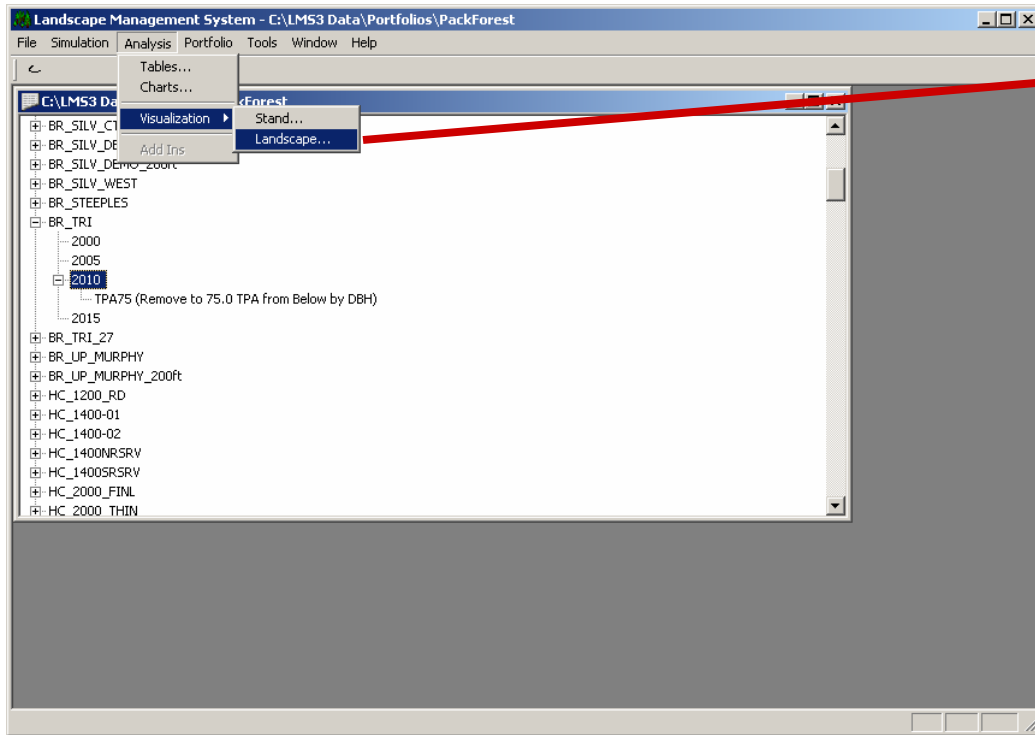
Stand Visualization



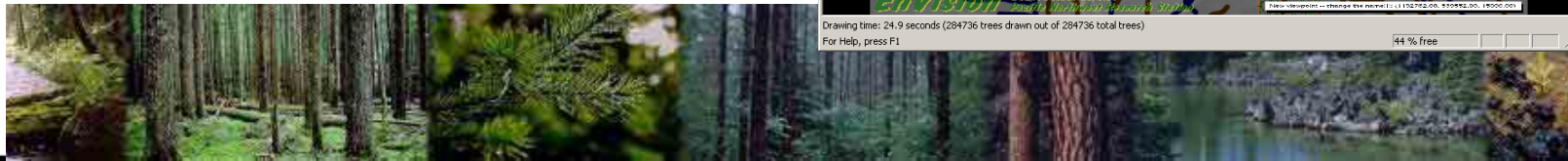
LMS can easily create stand level visualizations using the Stand Visualization System (SVS, USDA Forest Service). At right is an example of a stand visualization of the inventory for stand BR_TRI in 2000.



Landscape Visualization



LMS can present landscape level visualization using EnVision (USDA Forest Service). At right is an example visualization for the Pack Forest portfolio showing trees, stand boundaries (orange), roads (brown), and streams (blue).



LMS 3.0 - Treatments

Specify a Treatment

Select Year:
2000
2005
2010
2015

Select Stand:
 BR_1300_ROAD
 BR_B&T_NORTH
 BR_B&T_NORTH_200ft
 BR_BETH_1300
 BR_EBETH_RID
 BR_EBETH_RID_200ft
 BR_HIGH_PNT
 BR_LJ_MAC
 BR_LONECEDAR
 BR_MIDWAY
 BR_MIDWAY_200ft

Select a Treatment(s):

Name	Description
ClearCut	Remove to 0.0 TPA from Below by DBH
CT	Remove to 150.0 TPA from Below by DBH
PCT	Remove to 250.0 TPA from Below by DBH

New Edit OK Cancel

Treatment Specification

Removal Addition

Enable Removal Removal Type: Basic Output Record Type: Cut

Treatment Specification:
Retain: 0 TPA Value is %
Remove from: Below by: DBH

Species Subset:
 Enable Include
Add Remove

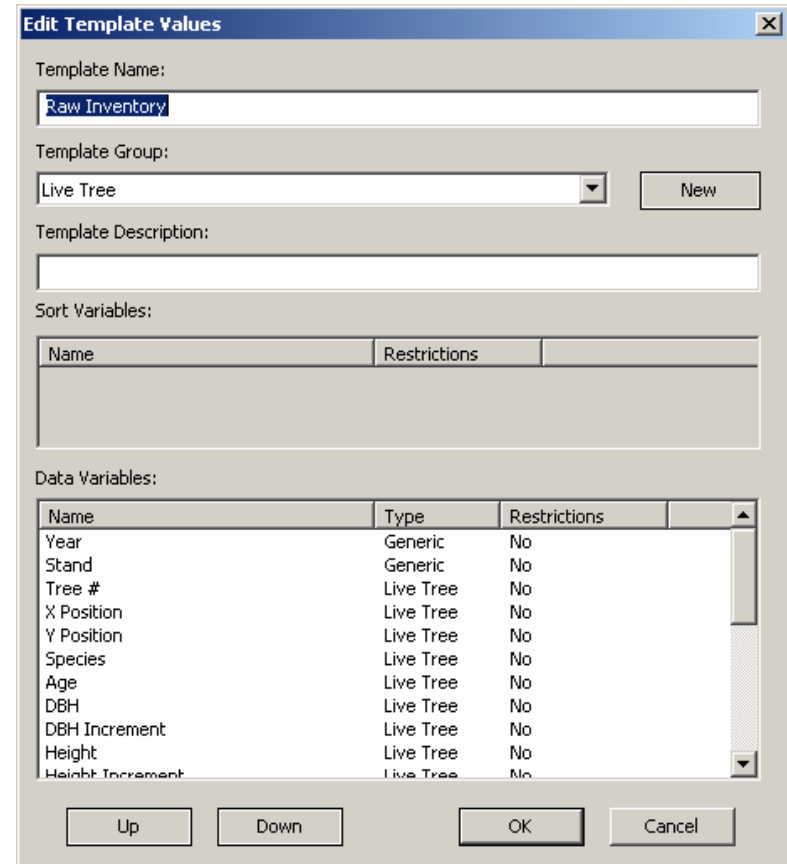
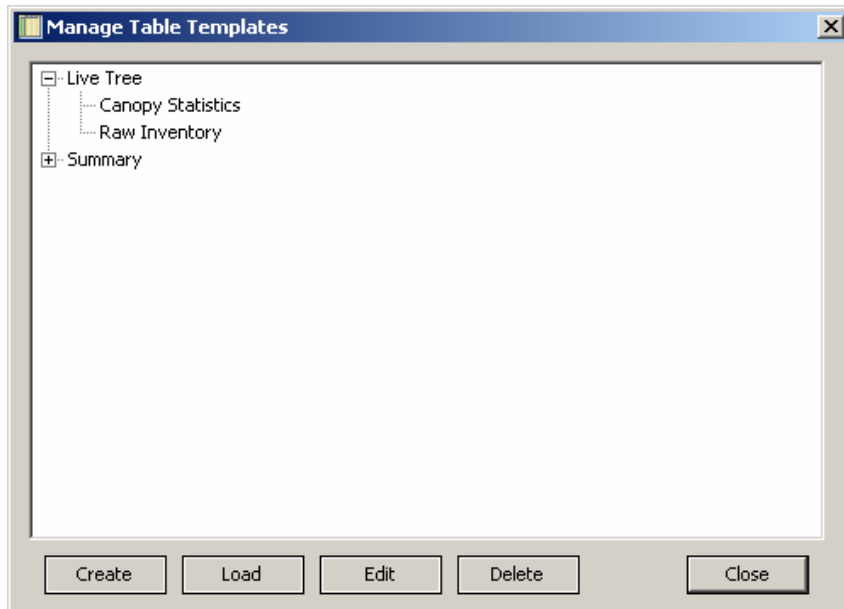
Diameter Subset:
 Enable
Minimum: 0
Maximum: 999

OK Cancel Apply

Users can create and name their own treatments.



LMS 3.0 – Table Templates



New tables can be created using the Create Table Templates Wizard.



LMS Tables

LMS can send tabular output to Excel, Access, or text files. Information ranges from raw inventory information to highly summarized information.

Year	Stand	Tree	Species	DBH	Height	CR	TPA	VolPerTreeBF	VolPerTreeCU	VolPerTreeMC	MCW
2000	BR_TRI	1	DF	18.1	126	0.55	2.44	340	67.7	67.7	20.7
2000	BR_TRI	2	DF	16.7	125	0.55	2.44	298	58.3	58.3	19.8
2000	BR_TRI	3	DF	16.3	103	0.55	2.44	236	50.4	50.4	19.6
2000	BR_TRI	4	DF	19.8	132	0.55	2.45	424	84.7	84.7	21.7
2000	BR_TRI	5	DF	22.1	127	0.55	2.45	623	118.9	118.9	23
2000	BR_TRI	6	DF	11.5	77	0.45	2.44	80	18.4	18.4	16.2
2000	BR_TRI	7	RA	9.9	61	0.25	2.42	75	14.9	14.9	21.1
2000	BR_TRI	8	DF	10.4	69	0.45	2.44	67	12.3	12.3	15.4
2000	BR_TRI	9	DF	13.3	87	0.55	2.44	154	31	31	17.6
2000	BR_TRI	10	DF	18.4	123	0.55	2.44	340	68.3	68.3	20.9
2000	BR_TRI	11	DF	13.1	85	0.55	2.44	143	28.4	28.4	17.4
2000	BR_TRI	12	DF	10.9	73	0.45	2.44	80	17.5	17.5	15.8
2000	BR_TRI	13	DF	19.6	119	0.55	2.45	398	79.7	79.7	21.6
2000	BR_TRI	14	DF	18.3	114	0.55	2.44	313	65.3	65.3	20.8
2000	BR_TRI	15	DF	11.9	77	0.45	2.44	92	22.2	22.2	16.5
2000	BR_TRI	16	DF	16.4	104	0.55	2.44	236	50.5	50.5	19.6
2000	BR_TRI	17	DF	19.4	116	0.55	2.45	365	73.5	73.5	21.5
2000	BR_TRI	18	DF	13.3	87	0.55	2.44	154	31	31	17.6
2000	BR_TRI	19	DF	21.3	128	0.55	2.45	564	108.5	108.5	22.6
2000	BR_TRI	20	RA	11.3	87	0.35	2.42	104	22.4	22.4	22.5
2000	BR_TRI	21	RA	7.6	52	0.15	2.41	34	6.7	6.7	18.6
2000	BR_TRI	22	DF	17.9	126	0.55	2.44	340	67.3	67.3	20.6
2000	BR_TRI	23	DF	8.4	56	0.35	2.44	45	8.3	8.3	13.7
2000	BR_TRI	24	DF	11.3	76	0.45	2.44	80	18.2	18.2	16.1
2000	BR_TRI	25	DF	10.6	70	0.45	2.44	80	16.2	16.2	15.6
2000	BR_TRI	26	DF	15.9	113	0.55	2.44	214	45.1	45.1	19.3
2000	BR_TRI	27	RA	9	59	0.25	2.42	61	10.9	10.9	20.2
2000	BR_TRI	28	DF	17.8	120	0.55	2.44	340	67.1	67.1	20.5
2000	BR_TRI	29	DF	24.3	136	0.65	2.45	741	144.6	144.6	24.2
2000	BR_TRI	30	RA	8.8	56	0.25	2.42	61	11.4	11.4	20
2000	BR_TRI	31	RA	8.5	55	0.15	2.41	61	11.1	11.1	19.7
2000	BR_TRI	32	DF	11.1	72	0.45	2.44	80	17.9	17.9	15.9

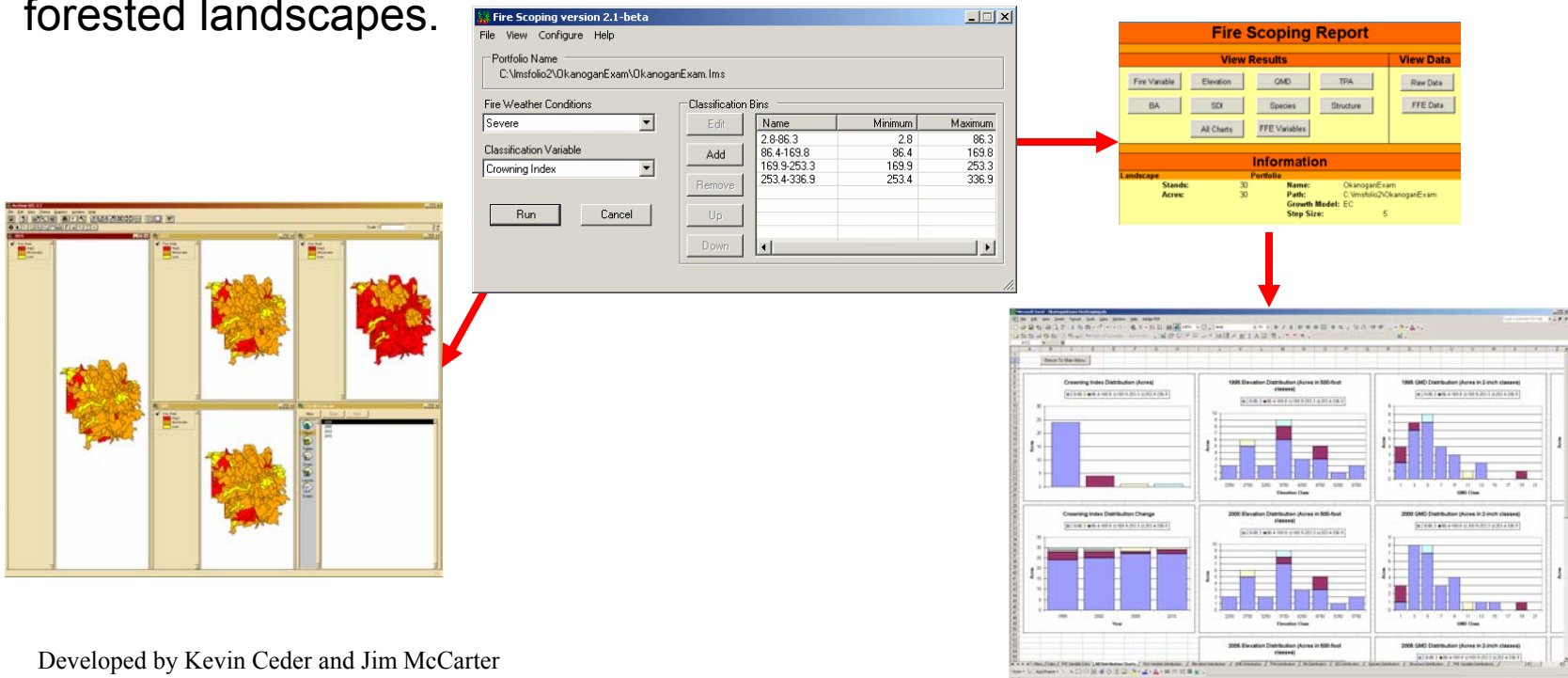
stand	species	DBHq	AveDBH	TPA	AveHt	TBA	SDI	CurtisRD	TVolPerAcres
00 BR_1300_ROAD	DF	6.41	6.24	348.57	30.1	78.23	171	30.9	1100.6
00 BR_1300_ROAD	RA	2.19	2.13	29.7	18	0.78	2.6	0.5	0
00 BR_1300_ROAD	TOTAL	6.19	5.92	378.27	29.1	79.01	175.2	31.8	1100.6
00 BR_RA_EA	BM	14.12	13.95	19.58	76.8	21.28	34	5.7	2801
00 BR_RA_EA	CH	18.25	17.22	14.71	78.7	26.72	38.6	6.3	4029.2
00 BR_RA_EA	DF	20.41	19.54	34.54	116.8	78.47	108.5	17.4	18280.4
00 BR_RA_EA	RA	10.71	10.43	58.49	66.8	36.6	65.3	11.2	5401.4
00 BR_RA_EA	TOTAL	15.32	14.23	127.32	83.3	163.07	252.5	41.7	30512
00 BR_STEEPLES	BM	9.28	9.1	6.8	64.8	3.19	6	1	379.4
00 BR_STEEPLES	CH	13.9	12.93	6.81	74.8	7.17	11.5	1.9	936.7
00 BR_STEEPLES	DF	16.1	14.83	60.29	89.8	85.28	129.5	21.3	17145.5
00 BR_STEEPLES	GF	13.14	12.05	4.09	79.8	3.85	6.3	1.1	730.8
00 BR_STEEPLES	RA	10.18	9.85	77.46	63.5	43.82	79.8	13.7	5859.6
00 BR_STEEPLES	RC	12.19	11.11	29.91	60.8	24.26	41.1	6.9	2435.6
00 BR_STEEPLES	WH	18.6	16.78	10.94	95.4	20.65	29.6	4.8	5012.8
00 BR_STEEPLES	YC	7.57	7.51	24.47	34.5	7.65	15.7	2.8	225.8
00 BR_STEEPLES	TOTAL	12.75	11.54	220.77	69.4	195.88	326.2	54.8	32726.2
2000 BR_TRI	DF	14.78	13.99	126.96	91.6	151.26	237.6	39.3	26320.7
2000 BR_TRI	RA	10.3	10.19	96.75	65.4	55.97	101.4	17.4	7685.9
2000 BR_TRI	WH	9.49	9.27	7.25	62.7	3.56	6.7	1.2	387.4
2000 BR_TRI	TOTAL	12.94	12.25	230.96	79.7	210.79	349	58.6	34394
2000 BR_TRI_27	BM	11.4	11.4	9.67	72	6.85	11.9	2	889.6
2000 BR_TRI_27	DF	19.03	18.16	126.56	118.9	249.96	355.2	57.3	58251.5
2000 BR_TRI_27	RA	13.2	13.2	9.66	73	9.18	15.1	2.5	1110.9
2000 BR_TRI_27	WH	6.75	6.75	19.26	49.5	4.79	10.3	1.8	212.1
2000 BR_TRI_27	TOTAL	17.34	16.14	165.15	105.4	270.79	399.3	65	60464.1

LMS has a number of different tables available. Additional tables can be added easily.



Fire Risk Analysis

Fire Risk Analysis – The fire risk analysis module includes the Fire and Fuels Extension (FFE) of the Forest Vegetation Simulator (FVS), the LMS-FFE Configuration Tool, the Fire Scoping Report, and the Fire Risk Mapper. Analytical and spatial outputs can be used to evaluate present risk conditions as well as to compare the effectiveness of simulated fire risk reduction treatments across real forested landscapes.

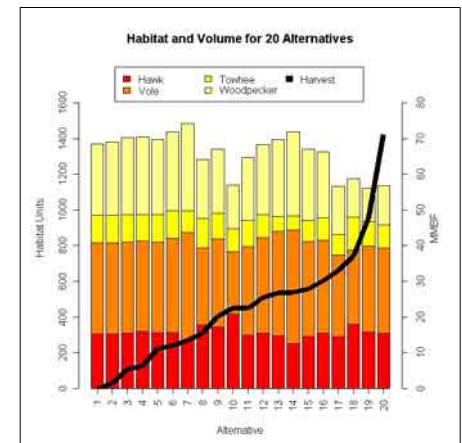
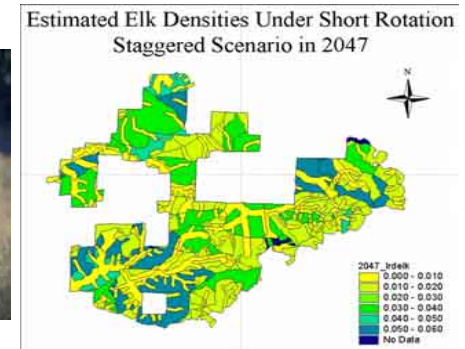


Developed by Kevin Ceder and Jim McCarter



Wildlife Habitat Modeling

Three approaches to modeling wildlife habitat in LMS are used. Habitat suitability modeling provides an estimate of habitat quality (an index from 0.0-1.0) and quantity (i.e. area of the landscape); structure-based habitat models associate particular species with forest structural conditions; and population models provide an estimates of animal density given habitat conditions. Habitat suitability models are analyzed to assess the tradeoffs in habitat units while structure-based habitat models can be used to estimate abundance/shortage of structure types (and by proxy habitat quantities) across large landscapes over time for alternative management approaches.



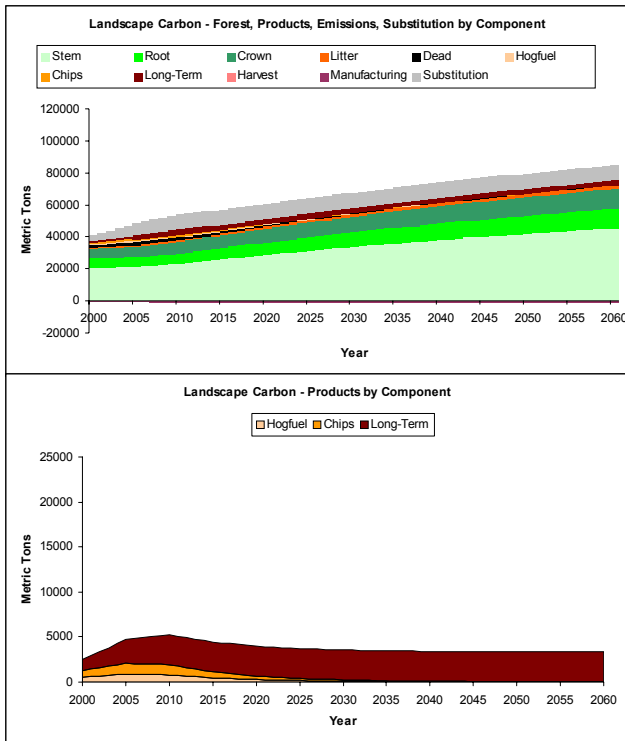
Developed by Kevin Ceder



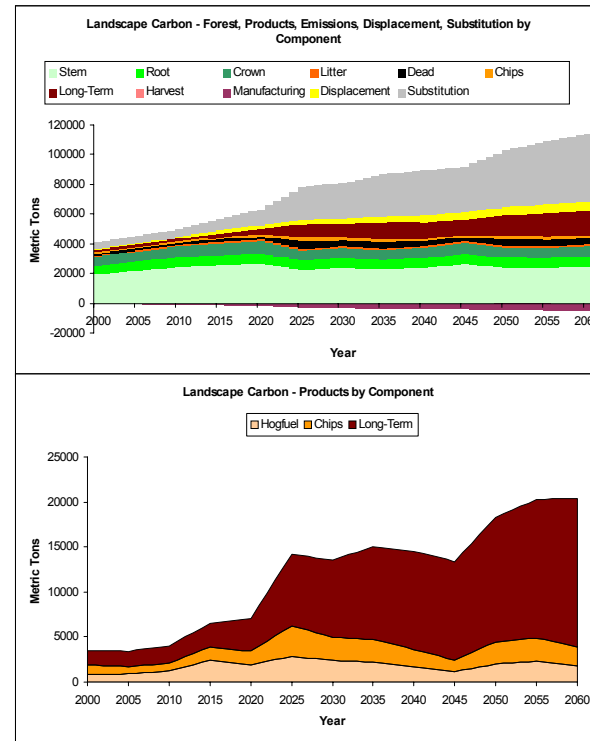
Carbon sequestration analysis

A life cycle assessment process has been developed to work with LMS, as an accounting system for forest carbon storage, substitution, and displacement over time under different management alternatives.

Management of 32 stand with 5 stands treated in 2000-2010

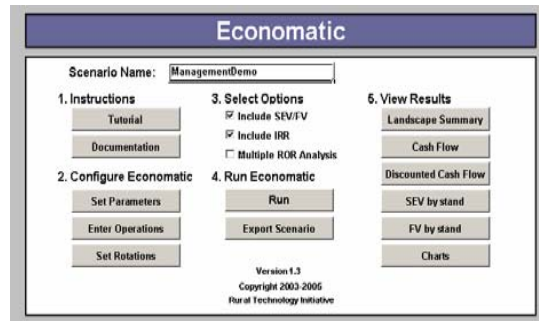


Management of 32 stands with 30 stands intensively managed.

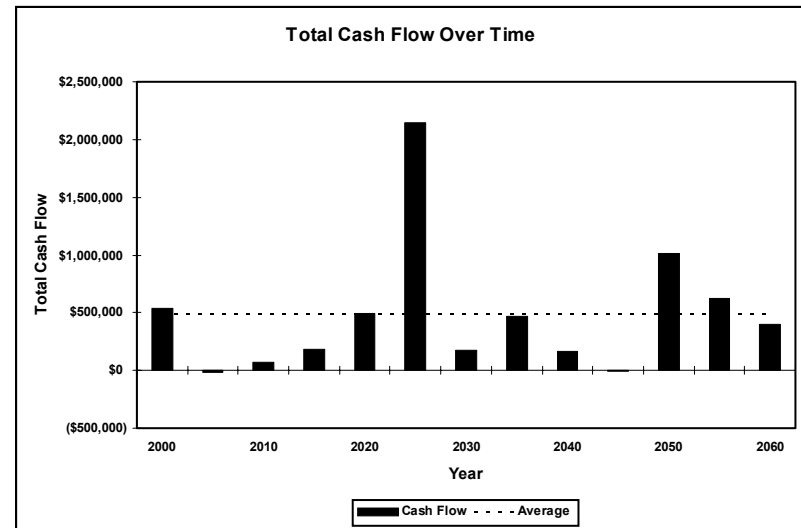


Economic Analysis with LMS

Economic is an easy-to-use economic and financial analysis companion for LMS. Economic takes management simulation data directly from LMS and automatically computes a variety of economic values, including discounted cash flow, equivalent annual annuity, soil expectation value, forest value, and internal rate of return. Users can customize costs, prices, tax rates, and other input parameters. Results are summarized at both the stand and landscape level in a series of tables and charts.



Management of 32 stands with 30 stands intensively managed.



Developed by Kevin Zobrist, Jeff Cornick, and Jim McCarter



Technology Transfer and Outreach

- Demonstrations
- Training Sessions
- Educational Partnerships
- Technical Support



Demonstrations of LMS and Related Tools

- Staff makes 50+ demonstrations a year
 - University classes, scientific meetings, professional meetings, RTI technical reviews, interested cooperators, mid-career professional training, forestry consultants, landowners, etc.
- Streaming video of presentations available



Training Sessions

- 2004 – 10 LMS training session
- 2005 – 8 LMS training sessions currently planned
 - Small landowners, state agencies, tribes, federal agencies, WSU extension, etc



Educational Partnerships

- Working with community colleges (WA and OR) on integrating the use of LMS into natural resource curriculum
- Cooperative Extension and Outreach
 - Washington State University
 - Penn State University
 - Developing relationships with others
- K-12 interface – working with Yale University, Pisgah Forest Institute, and Cradle of Forestry in America on LMS for K-12 students, along with customizations of LMS for Northeast and Southeast forests.



Technical Support

- Working with a number of universities and community colleges that use LMS as part of their curriculum.
- Supporting LMS users across the world
 - Universities, community colleges, state agencies, federal agencies, tribes, timber companies, small landowners.
- Since January 2004: Over 350 CD-ROMs distributed, 1500 copies downloaded from website (230 CD images)



Conclusions

- LMS is proving to be a useful platform for comparative analysis of alternative management approaches.
- Very useful in educational environments
- Visualizations are powerful communication tool.
- Other analyses (carbon, financial, wildlife) are becoming increasingly important
- Getting data in has always been the greatest hurdle



LMS available via Web

Landscape Management Project

Home University of Washington, College of Forest Resources Yale School of Forestry & Environmental Studies, Global Institute of Sustainable Forestry

WELCOME TO THE LANDSCAPE MANAGEMENT PROJECT WEBSITE

OPEN DENSE COMPLEX UNDERSTORY SAVANNA UNDERSTORY

The Landscape Management Project is a cooperative project between the University of Washington College of Forest Resources Silviculture Laboratory, Yale University School of Forestry and Environmental Studies, and the USDA Forest Service. Its purpose is to develop the concepts and tools needed to help forests provide the wide range of values people want – including commodities, wildlife habitat, fire safety, employment, and carbon sequestration. These values are best provided by coordinating the dynamic changes of forests across a landscape, rather than by trying to provide each or all values continuously on a single area.

Last Updated: Monday, June 10, 2002 11:37 AM

Landscape Management System

Home University of Washington, College of Forest Resources Yale School of Forestry & Environmental Studies, Global Institute of Sustainable Forestry

LMS Software

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Landscape Management System - Download

The following are available for downloading:

LMS install files are distributed as self-extracting or regular zip files. Use either [WinZip](#) or [PKZIP](#) to unarchive zip files or inspect exe files. Store the downloaded files in a temporary directory and then run the installation program (lms2*setup.exe) to install LMS.

Note: The updated Economic and Inventory Wizard mentioned in the RTI Newsletter are now available below!

LMS 2.0.457 - This is the latest release of LMS 2.x. This release includes updates to tables, updates to the Revision interface, ScenarioEditor update, new copy of Revision (2.10), and updated FVS variants. NOTE: The tutorials have been removed from the downloadable install. The are available from the Tutorial page and will become available as a separate install.
Last Update: 03/09/2004 (37.72MB, download time ~3 hours 8 minutes @ 28,800 baud)

LMS 2.0.45 CD-ROM Image - This is a CD-ROM image that you need to create the LMS Installation CD. This file was created using Easy CD Creator. You can create a CD-ROM using the File - Record CD from CD Image command. You can also request a CD-ROM to be mailed to you by sending email to lms@lms.cfr.washington.edu.

LMS-FFE Addon Install - This installation adds the FVS growth model variants that include the FFE extension, additional tables for displaying fire and fuel effects, and a fire scoring tool which displays landscape level fire risk and stand structure information summarized into graphic outputs. See the [LMS-FFE Addon Page](#) for additional information.
Last Update: 11/21/2003 (15,333KB, download time ~1 hour 10 minutes @ 28,800 baud)

Inventory Wizard 2.1 - The LMS Inventory Wizard is a Microsoft Access tool to help people get inventory data in the Landscape Management System. See the [LMS Inventory Wizard page](#) for additional information.
Last Update: 7/27/2004 (4.76 MB, download time ~ 28 minutes @ 28,800)

Economic 1.1 Update - The Economic 1.1 Update provides an updated version of the LMS Economic analysis released after LMS 2.0.457. See the [LMS Economic page](#) for additional information.
Last Update: 7/27/2004 (4.33 MB, download time ~ 25 minutes @ 28,800)

LMS_Analyst for ArcView 3.x - This update to LMS_Analyst fixes a major computation error in biogeometric analysis. Please download this version and replace your previous LMS_Analyst version file. See the [LMS_Analyst Home Page](#) for additional information and versions for ArcView 3.2a and 3.2a. This version of LMS_Analyst for ArcView 3.x is included in the LMS 2.0.458 and later installs.
Last Update: 08/05/2004 (18KB, download time ~ 5 seconds @ 28,800 baud)

Decision Analysis Tools:

The Decision Analysis companion tools (Scope&Group and Toggle) can be obtained from the [Decision Analysis Tools](#) page.

LMS Tutorials:

The LMS Tutorials have been moved to the [Tutorial Page](#)

Last Updated: Wednesday, July 28, 2004 9:31 AM

<http://lms.cfr.washington.edu/>

