Vegetation Dynamics Modeling Manual

Version 4.1
March 2006

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Please send comments to:
TNC-LANDFIRE
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Table of Contents

Introduction

The creation of vegetation models is a critical component of LANDFIRE and helps to document and synthesize the best available knowledge to-date on vegetation dynamics across the U.S. The refinement, development, application, and testing of vegetation models relies on expert input via workshops and peer-review. Thank you for your interest and engagement in this process!

Purpose of this Manual

This manual is designed to be a guidebook for people engaged in LANDFIRE vegetation modeling, including workshop participants and peer reviewers. It outlines the standards applied to all LANDFIRE vegetation models. This manual is not a complete guide to VDDT (Vegetation Dynamics Development Tool); it is meant to accompany the *VDDT User's Guide*[1] that is downloaded with the program. It is also not a complete overview of the LANDFIRE methodology, but only provides a brief overview of components that are related to vegetation modeling. For more information about LANDFIRE, please visit www.landfire.gov.

How Models Will be Used

- Vegetation models will be used in LANDFIRE to:
    - Provide succession and disturbance pathways and rates for the LANDSUM model, which simulates fire across the landscape and calculates a range of reference conditions used to calculate and map departure and Fire Regime Condition Class (FRCC).
    - Help map Biophysical Settings (BpS) and current conditions (existing vegetation in succession classes).

- Vegetation model description will supplement existing Fire Regime Condition Class Guidebook reference conditions.

- Models can be used in local and regional planning and management, including assessing FRCC at a project scale, testing alternative management scenarios, and for developing consensus and a shared vision of the management objectives and desired future conditions for landscapes.

We welcome your feedback and comments on this manual and the modeling process. Please send comments to:

TNC-LANDFIRE
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2424 Spruce St.
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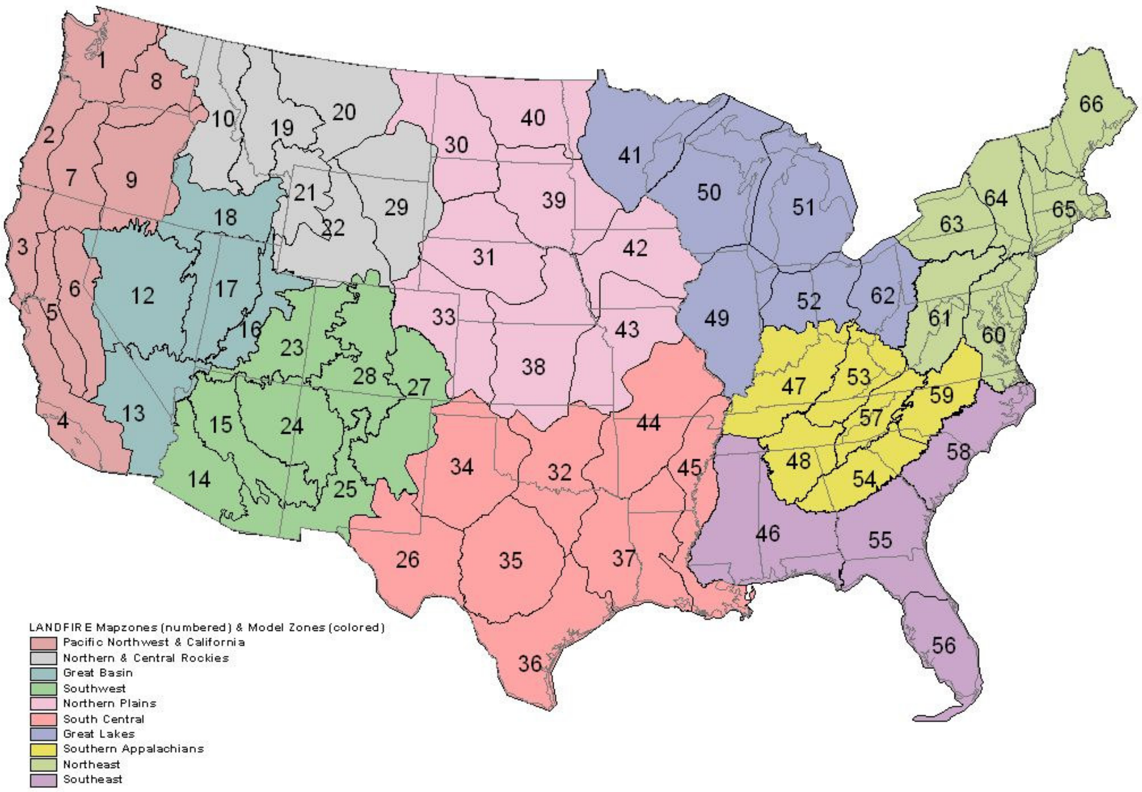
[1] ESSA Technologies Ltd. 2005. *Vegetation Dynamics Development Tool User's Guide, Version 5.0*. Prepared by ESSA Technologies Ltd., Vancouver, BC. 177 pp. Available at: www.essa.com.

Contacts

Regional Contacts for Vegetation Modeling



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Chapter 1: Background

On August 8, 2000, the President asked the Secretaries of the U.S. Department of Agriculture (USDA) and the Department of the Interior (DOI) to prepare a report recommending how to respond to severe, ongoing fire activity, reduce impacts of fires on rural communities and the environment, and ensure sufficient firefighting resources in the future. The report, officially titled *Managing the Impacts of Wildfire on Communities and the Environment: A Report to the President In Response to the Wildfires of 2000*, became known as the National Fire Plan (NFP). On October 13, 2000, the USDA Forest Service (USFS) delivered *A Cohesive Strategy: The Forest Service Management Response to the General Accounting Office Report GAO/RCED-99-65.* The National Association of State Foresters and the U.S. DOI participated with the USFS in developing this report. This report is referred to as the Cohesive Strategy.

In May of 2002, the Secretary of the Interior, Secretary of Agriculture, Director of the Council on Environmental Quality, and the Governors of the States of Montana, Arizona, Oregon, and Idaho met to approve an implementation plan for the *10-Year Comprehensive Strategy, A Collaborative Approach for Reducing Wildland Fire Risks to Communities and Environment.* A total of 17 Governors have since adopted this plan as a way to tackle the complex problems of wildland fire. The NFP, the Cohesive Strategy, and the 10-Year Comprehensive Strategy identify the need to invest in long-term solutions to the buildup of excessive hazardous fuels that threaten lives, property, and resources. Three nationally consistent, strategic data and inventory projects are being implemented to address the need for long term solutions: LANDFIRE, the Rapid Assessment, and the project-scale Fire Regime Condition Class Guidebook.

LANDFIRE

The LANDFIRE prototype project was conceived in 1999 and funded in 2002 to develop a comprehensive suite of standardized, multi-scale spatial data layers and software (Box 1.1) for two areas in the western U.S. The data support the NFP, the Western States' 10-year Comprehensive Strategy, and the President's Healthy Forest Initiative. LANDFIRE products are designed to be nationally consistent, locally relevant, and based on current, peer-reviewed scientific methods. The General Accounting Office described LANDFIRE in a 2003 report[2] as "the only proposed research project so far that appears capable of producing consistent national inventory data for improving the prioritization of fuel projects and communities" and recommended national implementation of the LANDFIRE Project.

Box 1.1: Example LANDFIRE Products

Data Layers

- ► Historical fire regimes
- ► Fire regime condition class
- ► Biophysical settings
- ► Environmental site potential
- ► Existing vegetation
- ► Existing structural stages
- ► FARSITE data layers

Computer Models

- ■ Landscape Simulation (LANDSUM)
- ■ Vegetation Dynamics (VDDT)

In October of 2003, the Wildland Fire Leadership Council sanctioned national implementation of LANDFIRE, and a national organizational structure was developed. National implementation will apply methods developed, tested, and refined through the western U.S. prototypes. The full suite of LANDFIRE products includes over 20 key goespatial data layers plus additional

[2] General Accounting Office Report. 28 August 2003. Geospatial Information: Technologies Hold Promise for Wildland Fire Management, but Challenges Remain. GAO-03-1114T. Available at www.gao.gov.

ancillary geospatial products and computer models (Box 1.1), including vegetation dynamics state-and-transition models. Products will be delivered by mapzone (Figure 1.1) from 2006 through 2009.

The LANDFIRE process includes using remotely sensed imagery and field plot data to determine existing vegetation composition and structure. Quantitative ecological models are created via expert workshops and paired with existing vegetation and biophysical settings to model historical fire regimes and Fire Regime Condition Class (FRCC).

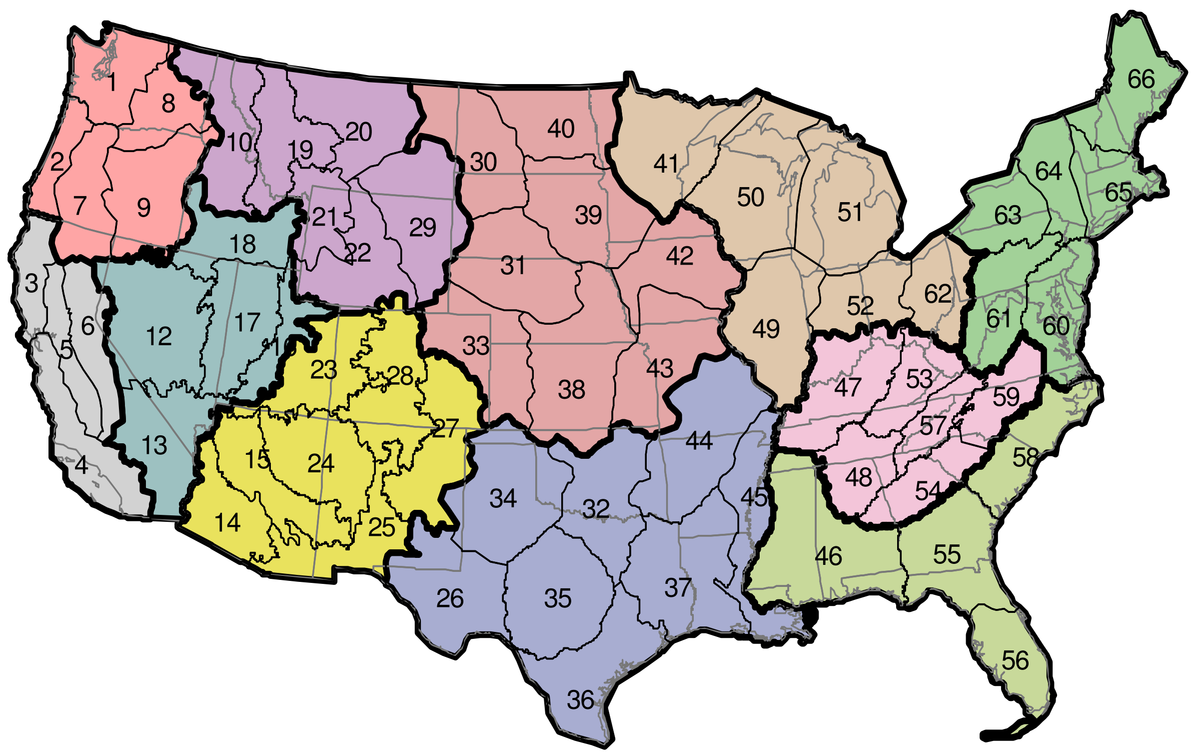

Figure 1.1: LANDFIRE map zones (numbered) and model zones (colored). LANDFIRE products will be completed and delivered by map zone in 2006-2009.

The Rapid Assessment

LANDFIRE included a one-year Rapid Assessment, which mapped and modeled FRCC at a broad-scale (i.e. 4th code watershed) resolution for the entire U.S. Rapid Assessment vegetation modeling was completed in the spring of 2005 and all Rapid Assessment data is scheduled for release in early 2006. The Rapid Assessment was designed to fill data needs before the entire suite of LANDFIRE products is available and will be replaced by LANDFIRE data. Additionally, the Rapid Assessment helped to refine vegetation dynamics models for use in regional and local FRCC assessments and provided templates for LANDFIRE quantitative vegetation dynamics models (Figure 1.2). The Rapid Assessment also provides technology transfer in the use of LANDFIRE data and the applications of FRCC.

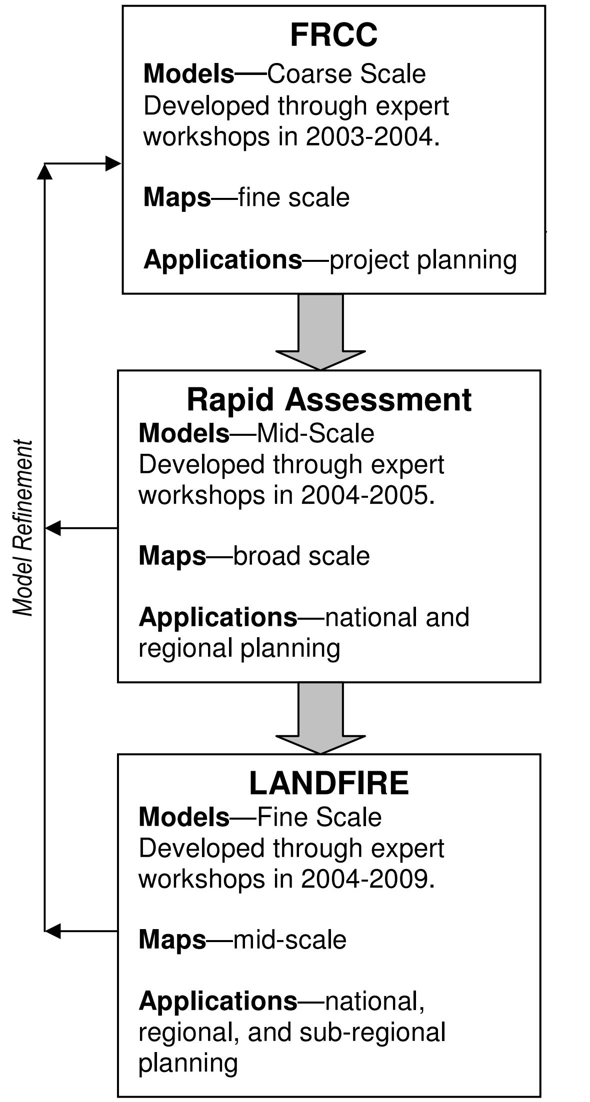

Figure 1.2: Scale and development of models for nationally consistent fire/fuels projects

Fire Regime Condition Class

FRCC is an interagency, standardized index for determining the degree of departure from the natural range of variability in vegetation, fuels, and disturbance regimes (Table 1.1). Assessing FRCC can help to guide management objectives, set priorities for treatments, and is mandated by federal agencies and incorporated into the US Healthy Forests Restoration Act as a monitoring measure.

A coarse-scale, national map of FRCC was created in 2002[3]. Regional and local training and assessments of FRCC are currently being conducted across the United States under the protocol of the FRCC Guidebook[4]. The Rapid Assessment and LANDFIRE will provide nationally consistent FRCC data that will allow for national and regional prioritization. The Rapid Assessment and LANDFIRE will not replace regional or local FRCC Guidebook assessments.

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[3] Schmidt, K.M., J.P. Menakis, C.C. Hardy, W.J. Hann, and D.L. Bunnell. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. General Technical Report RMRS-GTR-87. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 41 p. Available at: www.fs.fed.us/fire/fuelman.

[4] Hann, W.J., D. Havlina, A. Shlisky, et al. Interagency Fire Regime Condition Class Guidebook. 2004. Available at: www.frcc.gov.

Table 1.1: Definitions of fire regime condition classes

Fire Regime Condition Class	Fire Regime	Ecosystem Components
FRCC 1	Fire regimes are within historical range.	Risk of losing key ecosystem components is low. Vegetation attributes (species composition and structure) are intact and functioning within the historical range.
FRCC 2	Fire regimes have been moderately altered from their historical range. Fire frequencies are departed from historical frequencies by one or more return interval (either increased or decreased).	Risk of losing key ecosystem components is moderate. Vegetation attributes have been moderately altered from their historical range.
FRCC 3	Fire regimes have been significantly altered from their historical range. Fire frequencies are departed from historical frequencies by multiple return intervals (either increased or decreased).	The risk of losing key ecosystem components is high. Vegetation attributes have been significantly altered from their historical range.

The FRCC Guidebook methodology includes determining the departure in current vegetation composition and structure and fire frequency and severity from the historic range of variability, or reference conditions. Reference conditions are created using quantitative state-transition vegetation dynamics models, generated by experts. Models for much of the U.S. exist or are being developed through the FRCC Guidebook. Models developed for the Rapid Assessment and LANDFIRE will replace and supplement FRCC Guidebook models because they will be finer resolution and have more expert input (Figure 1.2).

Vegetation Dynamics Models

Vegetation dynamics models for the FRCC Guidebook, the Rapid Assessment, and LANDFIRE are quantitative, state-transition (box) models. Modeling is necessary to determine the natural range of variability in vegetation composition and structure. All projects use the modeling software VDDT[5] (Vegetation Dynamics Development Tool), which is a public domain, aspatial tool (available at www.essa.com). For LANDFIRE, VDDT models are applied in a spatial modeling tool, LANDSUM[6], to simulate fire and calculate the historic range of variability across real landscapes.

Models for all three projects are developed during workshops where regional vegetation and fire ecology experts synthesize the best available data on vegetation dynamics and disturbance for vegetation groups in their region. Most experts are trained in VDDT software and generate models during the workshop. Extensive peer review processes following model development garner additional expert engagement and refine the vegetation models.

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[5] ESSA Technologies Ltd. 2005. Vegetation Dynamics Development Tool User's Guide, Version 5.0. Prepared by ESSA Technologies Ltd., Vancouver, BC. 177 pp. Available at: www.essa.com.
[6] Keane, R.E., R. Parsons, P. Hessburg. 2002. Estimating historical range and variation of landscape patch dynamics: limitations of the simulation approach. Ecological Modeling 151: 29–49.

Quantitative models are based on inputs such as fire frequency and severity, the probability of other disturbances, and the rate of vegetation growth. Inputs are derived from literature review and expert input during and after modeling workshops. Models simulate several centuries of vegetation dynamics and outputs such as percent of the landscape in each class and the frequency of disturbance are recorded. Outputs are checked against available data whenever possible and are peer-reviewed during and after expert workshops. These outputs are then used to calculate FRCC using the Guidebook methodology.

For More Information

Please see *Appendix A* for links and additional resources. *Appendix B* contains letters of support from the USDA Forest Service, the Bureau of Land Management, and the US Fish and Wildlife Service. You may also contact LANDFIRE staff, listed in the *Introduction*.

Chapter 2: Overview of Vegetation Dynamics Modeling

Components of Vegetation Dynamics Models

Every LANDFIRE vegetation dynamics model consists of two major components: a quantitative vegetation dynamics model, created using the software VDDT[7]; and model documentation captured in the LANDFIRE ModelTracker Database.

VDDT (Box 2.1, Figure 2.1) is a quantitative state-and-transition (or "box") model that combines information about vegetation succession, such as the rates and pathways of growth over time, and disturbance, such as the probabilities and effects of a perturbation. VDDT applies the input data across an unrelated, aspatial grid of pixels and returns output such as the overall percentage of a class over time and the likelihood of different disturbances (Figure 2.2). In LANDFIRE, VDDT inputs are used as inputs for the model, LANDSUM[8], which applies VDDT data spatially. For more information about VDDT, see Chapter 5 or the *VDDT User's Guide*[6].

ModelTracker Database is a tool created in Microsoft Access for LANDFIRE vegetation modeling used to track inputs, outputs, assumptions, contributors, peer-review comments, and other data for each model. For more information about ModelTracker, see Chapter 4.

Box 2.1: About VDDT

For more information, visit www.essa.com or check the *VDDT User's Guide*[6].

History

→ VDDT is public domain and was originally developed for the Interior Columbia River Basin Ecosystem Management Project.
→ VDDT is used in nationally consistent fire and fuels projects like LANDFIRE and Fire Regime Condition Class, and at project scales in land management or conservation planning.
→ VDDT has been significantly revised and improved via the LANDFIRE project.

Model Assumptions

→ VDDT is non-spatial; terrain and contagion are not incorporated. VDDT can be paired with companion spatial programs, including LANDSUM, which combines VDDT models and spatial data to simulate fire across landscapes.
→ The user must stratify the landscape into units with similar succession and disturbance characteristics, like Biophysical Settings.

How the Model Works

→ The user defines classes on the landscape by composition, structure, and age; assigns a main successional pathway; and assigns probabilities and pathways for different disturbances.
→ VDDT partitions the landscape into a user-determined number of pixels (e.g. grid cells). Each pixel is initially assigned to a class and age.
→ When the model is run, VDDT stochastically simulates the probability of disturbance. If a disturbance does not occur, pixels are moved along the pathway defined as succession.
→ Output of VDDT includes the percent of the landscape in each class over time and the probability of different disturbances.

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[7] ESSA Technologies Ltd. 2005. Vegetation Dynamics Development Tool User's Guide, Version 5.0. Prepared by ESSA Technologies Ltd., Vancouver, BC. 177 pp. Available at: www.essa.com.
[8] Keane, R.E., R. Parsons, P. Hessburg. 2002. Estimating historical range and variation of landscape patch dynamics: limitations of the simulation approach. Ecological Modeling 151: 29–49.

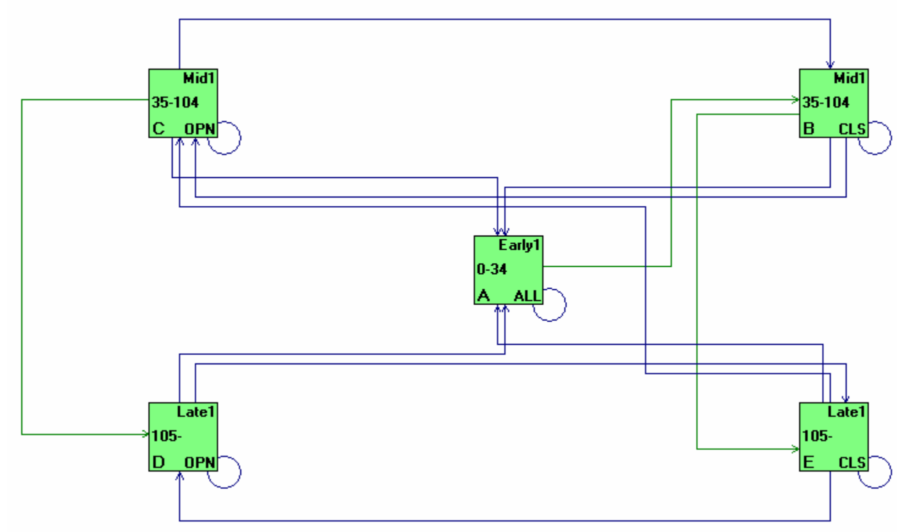

Figure 2.1: A typical LANDFIRE VDDT state-and-transition model. Each box represents a vegetation class made up of characteristic vegetation composition and structure. Each arrow represents a transition from one class to another based on vegetation growth (succession) or a disturbance (e.g. fire or other).

Model Inputs
- ► Fire frequency and severity
- ► Probability of other disturbances
- ► Rate of vegetation growth and development
- ► Vegetation classes based on density and composition

VDDT →

Model Outputs
- ► Percent of landscape in each vegetation class
- ► Frequency and severity of fire
- ► Frequency of other disturbances

Figure 2.2: Inputs and outputs to VDDT models.

Vegetation Modeling Process

Vegetation models for LANDFIRE are developed for each mapzone or group of mapzones (Figure 1.1) through a series of workshops, meetings, and electronic review forums. Models from other efforts, including the LANDFIRE Rapid Assessment and FRCC Guidebook, are used as templates or draft models for LANDFIRE. They are then refined via small group meetings, larger workshops, and peer-review processes to broaden the expert input, refine the geographic specificity, and improve the input data.

Workshops are scheduled by mapzone (or groups of mapzones). Workshop attendees are usually trained in the software, VDDT, and spend 2-5 days modeling in VDDT and documenting model assumptions in ModelTracker database. Some workshops also have VDDT experts available to "drive" the model for participants. As of December 2005, over twenty vegetation modeling workshops have been conducted across the U.S. for the Rapid Assessment and LANDFIRE, engaging over 300 experts nationwide.

The model peer review process engages both workshop participants and those unable to attend workshops. Peer reviewers are not required to know VDDT, but it is preferred. Reviewers complete a standardized form and respond to specific questions about each model (*Appendix C*). Reviewers can choose to review a brief (3-10 page) document that summarizes each model (from ModelTracker database) alone, or in conjunction with the actual, quantitative VDDT model.

For more information about the model development and review process in your region, contact your regional lead listed in the *Contacts* section.

How models are conceived

There are three main steps to conceiving vegetation dynamics models, each elaborated upon below:

1. Identify the units being modeled. LANDFIRE units are Biophysical Settings (BpS), as defined by Ecological Systems[9].
2. Identify the succession classes within each unit. Classes are defined by combinations of cover (i.e. species composition) and structure (i.e. percent cover and height of vegetation) and must be mutually exclusive, mappable units for LANDFIRE.
3. Identify the causes and rates of transitions from one class to another. Succession, fire, insects, weather related disturbances, and grazing are all examples of transitions.

Biophysical Settings Units

LANDFIRE vegetation dynamics models describe Biophysical Settings (BpS), or recurring groups of biological communities found in similar environments and influenced by similar dynamic processes. For BpS units, LANDFIRE uses Ecological Systems[10], a nationally consistent, hierarchical vegetation classification developed by NatureServe. Ecological Systems are defined by multiple environmental factors (Box 2.2) that help to explain the spatial co-occurrence of biological communities. A list of the Ecological Systems in LANDFIRE's draft BpS legend can be found in *Appendix D*.

Box 2.2
Diagnostic Classifiers of Ecological Systems
(Categories and Examples)

Ecological Divisions
- Continental Bioclimate and Phytogeography

Bioclimatic Variables
- Regional Bioclimate

Environment
- Landscape Position, Hydrogeomorphology
- Soil Characteristics, Specialized Substrate

Ecological Dynamics
- Hydrologic Regime
- Fire Regime

Landscape Juxtaposition
- Upland-Wetland Mosaics

Vegetation
- Vertical Structure and Patch Type
- Composition of Component Associations
- Abundance of Component Association Patches

[9] Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe. Arlington, Virginia. Available at: www.natureserve.org/getData/ecologyData.jsp.

Why LANDFIRE uses Ecological Systems. Ecological Systems were selected for mapping and modeling Biophysical Settings in LANDFIRE because:

- They are consistent across the nation and available now.
- They include ecological dynamics, like fire, so they are consistent with FRCC methodology.
- They can be mapped at the resolution necessary for LANDFIRE.
- Their vegetation dynamics, including succession and disturbance, can be modeled.
- They are identifiable from plot data.
- They can be cross-walked to other vegetation units and classifications.
- They nest within the National Vegetation Classification hierarchy (US-NVC)[11, 12] because they are comprised of groups of US-NVC Associations.

Refining Ecological Systems for Biophysical Settings. The vegetation modeling process helps to refine and improve Ecological Systems and LANDFIRE's BpS legend in two ways. First, modelers and model reviewers can provide feedback directly to the developers of Ecological Systems (NatureServe) via model documentation. This feedback will be used to improve future iterations of the classification as well as inform mapping and modeling for LANDFIRE.

Second, modelers have the option to lump or split BpS based on geography, physical gradients, and/or fire regimes (Figure 2.3). Lumping occurs when Ecological Systems are defined too finely for vegetation models and they can be combined into one model. For example, two riparian Ecological Systems may have very similar dynamics, and a single vegetation dynamics model can easily represent both types. Splitting occurs when Ecological Systems are defined too coarsely to represent differences in biophysical gradients. For example, within a single LANDFIRE mapzone (Figure 1.1), an Ecological System may function differently depending on its location along an elevational gradient. This Ecological System may then have two BpS models associated with it—one that represents dynamics at lower elevations, and one that represents dynamics at higher elevations.

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[11] Federal Geographic Data Committee. 1997. Vegetation Classification Standard. FGDC-STD-005. Available at: http://www.fgdc.gov/Standards/Documents/Standards/Vegetation.

[12] Grossman, D.H., D. Faber-Langendoen, A.W. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume I: The National Vegetation Classification Standard. (Draft June 1997.) The Nature Conservancy, Arlington, VA. 92 pp.

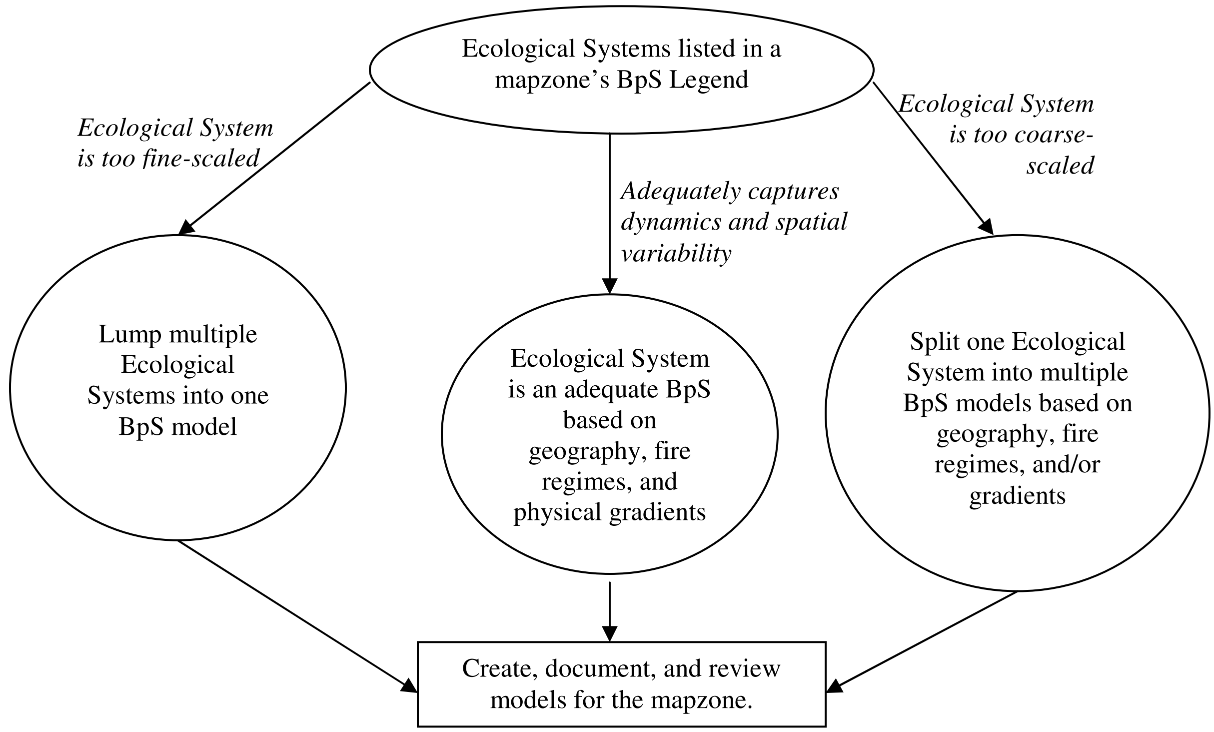

Figure 2.3: The process of refining Ecological Systems for LANDFIRE BpS

Defining Succession Classes

In LANDFIRE, each BpS can have up to five succession classes, defined by combinations of cover (i.e. species composition) and structure (i.e. percent cover and height). The classes are named with generic labels (Table 2.1). A standard model (Table 2.1) has been widely adopted, but can be adjusted for any BpS. Because succession classes must be mappable, they must be mutually exclusive by combinations of cover and height. The worksheet in *Appendix E* helps to design mutually exclusive classes. Definitions of succession classes are informed by literature, local data, and expert knowledge via modeling workshops and peer-review.

Table 2.1: Classes in the standard five-box model. Letters represent unique classes and correspond to boxes in the state-transition models (Figure 2.1). Class labels can be adjusted, but no more than 5 classes are allowed.

	Structural Stage	
Cover Type	**Closed**	**Open**
Early development	A	
Mid-development	B	C
Late-development	E	D

The components that define succession classes for LANDFIRE include the following:

- Indicator species of each class
- Range of canopy cover (by class) of the upper layer lifeform (Table 2.2)
- Range of height (by class) of the upper layer lifeform (Table 2.3)
- Tree diameter class (if applicable) (Table 2.4)
- Age range (succession age) of each class.

Table 2.2: Canopy Cover Classes

Class	*Range*
1	11-20%
2	21-30%
3	31-40%
4	41-50%
5	51-60%
6	61-70%
7	71-80%
8	81-90%
9	91-100%

Table 2.3: Lifeform Height Classes

Trees		*Shrubs*		*Herbaceous*	
Regeneration	<5 m (~<16 ft)	Dwarf	<0.5m (~<1.6 ft)	Short	<0.5m (~<1.6 ft)
Short	5-9 m (~16-30 ft)	Short	05.-0.9m (~1.6-3 ft)	Medium	0.5-0.9m (~1.6-3 ft)
Medium	10-24 m (~30-78 ft)	Medium	1-2.9m (~3-9.5 ft)	Tall	>1m (~3-9.5 ft)
Tall	24-49 m (~78-160 ft)	Tall	>3m (~>9.5 ft)		
Giant	>50 m (~>160 ft)				

Table 2.4: Tree Diameter Classes

Size Class	*Diameter Class*
Seedling	<4.5 ft tall (~<1.4 m)
Sapling	>4.5 ft tall; <5” DBH (~>1.4m tall; ~<13 cm DBH)
Pole	5-9” DBH (~13-23 cm DBH)
Medium	9-21” DBH (~23-53 cm DBH)
Large	21-33” DBH (~53-84 cm DBH)
Very Large	>33” DBH (~>84 cm DBH)

Defining Transitions

In LANDFIRE, there are two main causes of transitions between succession classes: succession and (natural) disturbance. To attribute succession and disturbance in vegetation dynamics models, users must define (a) how often the transition occurs, and (b) the resulting pathway, or succession class. In general, succession is defined as the vegetation growth over time under natural disturbance regimes. More than one succession pathway (i.e. alternative succession pathways) can be attributed.

Disturbances are defined as dynamics that affect the system under reference conditions. The following disturbances can be used in LANDFIRE vegetation models:

- Replacement fire (>75% top-kill)
- Mixed severity fire (25-75% top-kill)
- Surface fire (<25% top-kill)
- Insects and disease
- Wind, weather, or other stress events
- Native grazing
- Competition or lack of seed source
- User-defined (optional types)

Definitions of rates and pathways of transitions are informed by literature, local data, and expert knowledge via modeling workshops and peer-review.

Chapter 3: Data Files for Modeling and Reviewing

Data Needed

Whether you participate in a modeling workshop or model peer-review, you will need to download some data files. Table 3.1 summarizes data needed for both processes.

Table 3.1: Data files needed for modeling and reviewing.

Data File	**Description**	**Location**
MODELING		
Modeling Manual	Reference document explaining LANDFIRE vegetation dynamics modeling background, process, procedures and standards.	www.landfire.gov
ModelTracker	Blank copy of the database used to document and describe LANDFIRE models.	
VDDT Database	A VDDT database with model templates.	
VDDT Software	Vegetation Dynamics Development Tool software.	www.essa.com
REVIEW		
ReadMe Instructions	Instructions to guide reviewers through the review process.	www.landfire.gov and private website*
Model Peer Review Form	Form that allows reviewers to document their review of models.	
Draft Models	Draft models that need to be reviewed.	private website
Maps	Maps of the LANDFIRE mapping zones with reference features.	

*Ask your regional lead about the private website.

Installing VDDT

To participate in a workshop or review models, you may want to use the software, VDDT. To download it:

1. Visit www.essa.com[13] and go to Downloads—Software—VDDT Download Page.
2. Follow the instructions for downloading and installing VDDT. You will need to email ESSA for a password, so do this several weeks prior to the workshop.
3. Test the functioning of VDDT by running one of the demo models that comes with the program or by following the instructions in the section below, *Testing VDDT*.
4. Proceed to the next section, *File Structure and Data Files*.

Testing VDDT

The following steps will quickly test the functioning of VDDT on your computer. These steps are outlined in greater detail in the rest of the Manual.

1. Open VDDT. You can access VDDT from the Start Menu or from an icon on your desktop.

2. Point VDDT to the database you wish to work in. Go to File—Database. Navigate to the database. Select it and click the Open button.

[13] ESSA Technologies Ltd. 2005. Vegetation Dynamics Development Tool User's Guide, Version 5.0. Prepared by ESSA Technologies Ltd., Vancouver, BC. 177 pp.

- If you are a modeler, navigate to either the sample database (available at www.landfire.gov or with the VDDT software download) or to an existing database you wish to work in.
- If you are a reviewer, navigate to the draft models database you downloaded from the model review website specified by your regional lead.

3. Open an existing model. Go to File—Open. Select a model and click on the Open button. The model will open. Double-click on any of the green boxes to get information about the parameters of each class.

4. Run the model.
    - Go to Run—Settings to open the *Run Settings* dialogue box. Select the *Initial Conditions* tab and click on the Normalize button.
    - Select the *Options* tab. Click on the box next to Use Time Since Disturbance if it is not greyed-out (if it is greyed out, skip to step #5). Click on the Select button to the right of Use Time Since Disturbance to open the *Time Since Disturbance Groups* dialogue box. For the AltSuccession Transition Type, use the drop down menu to select AllFire as the Associated TSD Group.
    - Click the Run button. You should see a progress bar indicating that the model is processing.

5. Go to Results—Bar—Class. A graph displaying the results of your model should appear.

6. If you did not encounter any errors, VDDT is working on your machine! Congratulations—you are now a modeler.

Chapter 4: Model Reporting and Documentation in ModelTracker Database

For Workshops: If you are developing a model in workshops or meetings, you will use the ModelTracker Database for model reporting and documentation (available at www.landfire.gov). Please complete and/or edit the form in the database for every model as completely as possible.

For Peer-Review: If you are a reviewer, you will be reading PDF files generated from the ModelTracker Database. *Appendix F*, *Key to ModelTracker Database Fields* may help explain some of the information you find (or should find) in the database description for each BpS.

About the Model Tracker Database

The model tracker database is an Access 2000 database. You will need Access 2000 or higher to run the database.

Navigating in the database

- ❑ When you first open the database, a form called LANDFIRE Vegetation Models will open. You will enter all of the information here.
- ❑ The database consists of records (pages); each record contains the information for one of your BpS (they are blank until you enter the data).
- ❑ To navigate between BpS records, use the arrows at the bottom of the window next to the word "Record".
- ❑ Blue fields are automatically populated by the database.
- ❑ Green fields should match values in the VDDT model.
- ❑ Access will save the database as you work without your instruction. To save manually, simply click the save button (looks like a small floppy disk) on the tool bar.

Entering Information into the Database

- ❑ The information you enter into the database will become the description document for the BpS. Thus, please be clear, concise, and use proper grammar, including complete sentences and correct spelling.
- ❑ Please cite sources in the longer description fields, as appropriate. Please list all references (not just those cited) in alphabetical in the *References* field.
- ❑ The information you enter into the database will be proofread and checked by the regional modeling lead and national LANDFIRE team members. Please make their job easier by being clear about your meaning.
- ❑ If you are uncertain about anything in the database, please ask your regional lead. You can also log comments and concerns in the fields called *Comments* and *Issues/Problems*.
- ❑ The Key on the following pages explains each of the fields in the database.

Hints

- ⇨ Click the View Report button (upper left) to see the formal, publishable summary of the information in your record.
- ⇨ The Title Bar at the bottom of the Access window (lower left) provides instructions for the field your cursor is currently in.

Chapter 5: Using VDDT

This chapter outlines the standardized VDDT modeling techniques for LANDFIRE and is designed to accompany the *VDDT User's Guide*[14].

Starting a Model

1. Decide how you will create your model. If you are creating models in workshops, you may choose to create models two different ways: using an existing model or using a model template.

    - Existing models
        - There are currently over 300 models available as starting points, created through the FRCC Guidebook[15], the LANDFIRE Rapid Assessment, and other LANDFIRE mapzones. Some of these models will be appropriate starting points for your LANDFIRE models. Your regional lead will provide these, or you can download models from www.landfire.gov.
    - Model templates
        - There are three options for templates: 5-box, 4-box, and 3-box models (Table 5.2). You will want to select the template that is most appropriate for your system. Templates provide a blank model structure—no succession or disturbances have been attributed. Your regional lead will provide these, or you can download a sample database with these templates from www.landfire.gov.

Table 5.2: Templates for LANDFIRE models

Model Name	Most Common Uses
5-Box Model	• Forested systems • Complex shrublands
4-Box Model	• Shrublands with trees • Grasslands with shrubs
3-Box Model	• Grasslands • Simple shrublands

2. Open VDDT. Double-click its icon on your desktop or navigate to C:\Program Files\VDDT.

3. Point VDDT to the database that contains models you want to start with. This will be either a database with existing models or a database with model templates (see step one above for more information). Go to File—Database. Browse to the database from which you want to work, select it, and click the Open button.

4. Open a model from the database. Go to File—Open. Select a model, and click on the Open button. The model will open. Double-click on any of the green boxes to get information about the parameters of each class.

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[14] ESSA Technologies Ltd. 2005. Vegetation Dynamics Development Tool User's Guide, Version 5.0. Prepared by ESSA Technologies Ltd., Vancouver, BC. 177 pp. Available at: www.essa.com.
[15] Hann, W.J., D. Havlina, A. Shlisky, et al. Interagency Fire Regime Condition Class Guidebook. 2004. Available at: www.frcc.gov.

5. Save your model. You can save to the current database with a new name or to a different database.
    - To save the model to the current database, click on File—Save As. In the Project Name box at the bottom, type the unique BpS code. In the Description box add the BpS name and click Save. You are now able to manipulate the model; remember to save frequently (File—Save).
    - To save the model to a different database, go to File—Export—Project to MDB. Browse to the database you want to export to, select it, and click the Open button. In the *Export Project As* dialogue box, name and describe your model. Click the Export button. To open your model in the database you just saved to, you must 1) point the model to the new database and 2) open the model.
        1. Go to File—Database. Browse to the database. Select it and click the Open button.
        2. Go to File—Open. Select your model and click the Open button.

State (Box) Definitions

1. Each green box in the VDDT successional pathway diagram (SPD) represents a succession class. These classes are user-defined combinations of composition and structure (Figure 5.1).

2. In LANDFIRE modeling, there can be no more than five successional classes (boxes), but you can have fewer than five. The standard five classes are based on combinations of structural stage and cover type (Table 2.1), but these can be changed by the user:
   - A: early development, post-replacement
   - B: mid-development closed
   - C: mid-development open
   - D: late development open
   - E: late development closed

The structural stages (open, closed, and all) are defined by the user in model documentation based on cover breaks. These vary greatly between BpS. The cover types (early, mid, and late) are also user-defined in model documentation.

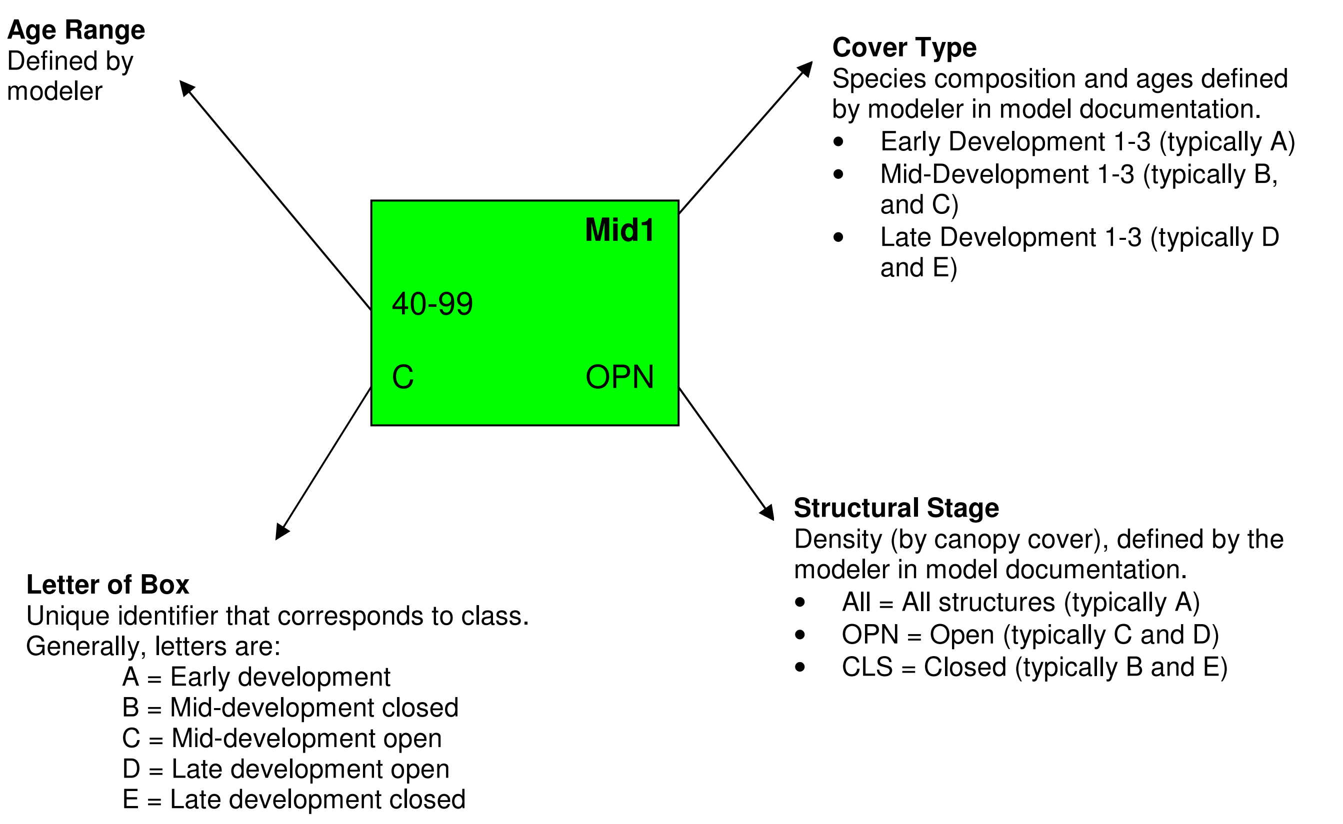


Figure 5.1: Anatomy of a LANDFIRE box (class) in VDDT. Also see Table 2.1 for a description of each of the five classes (boxes) used.

3. VDDT will not allow users to have two boxes with the same cover/structure combination. If two of your boxes are identical in development (e.g. mid) and in structure (e.g. open), but have different composition and warrant being separate boxes, you may choose to change the name of one of the boxes. There are up to 27 structure/composition combinations (Table 5.3), but each model can have a maximum of 5 boxes.

Table 5.3: Cover-Structure combination options

Cover Type Options	***Structural Stage Options***
Early1	All
Early2	Closed
Early3	Open
Mid1	
Mid2	
Mid3	
Late1	
Late2	
Late3	

To change the name (structure/cover combination) of a box:

- Go to Diagram—Edit Class Cover and Stage.
- In the *Edit Class* dialogue box, type the letter of the box (class; A-E) you want to edit.
- From the Cover Type drop-down menu, select the cover type for the class. Always use the class number in sequence (e.g. start with 1, then 2, etc.).
- From the Structural Stage drop-down menu, select the structural stage.
- Click OK.

Transition (Arrow) Definitions

Each line and arrow in the SPD represents a pathway between succession classes, resulting from either probabilistic transitions (disturbances; blue lines) or deterministic transitions (succession; green lines). You can change the pathways viewed in the SPD by:

1. Selecting Diagram—Redisplay Pathways. In the *Redisplay Pathways* dialogue box, select the pathways you want VDDT to show and click OK.

2. You can view the pathways for an individual box by right-clicking on that box and selecting Show Class Pathways.

3. To redraw all pathways, select Diagram—Redisplay Pathways. In the *Redisplay Pathways* dialogue box, check the box next to All Transitions, and click OK.

Attributing the Model

You may want to use a worksheet to help you keep track of changes you make to each model. An example worksheet is in *Appendix H*. The Cheatsheet in *Appendix G* also walks you through attributing the model.

Users must attribute two components in VDDT models: succession (i.e. deterministic transition) and disturbance (i.e. probabilistic transition). They are explained in more detail in the sections below and in the *VDDT User's Guide*[16], which comes with the program.

How the model treats Succession (Deterministic Transitions) and Disturbance (Probabalistic Transitions)

Succession. VDDT treats a single succession pathway deterministically. After the designated number of timesteps (the age range for a class), a pixel transitions along the main succession pathway, designated by the user. Users can also attribute alternative succession pathways as disturbances.

Disturbance. VDDT treats multiple disturbance pathways probabilistically. Each year, the model stochastically simulates whether or not a disturbance happens to each individual pixel within a class based on the probability of that disturbance, input by the user (probability is equal to 1/annual frequency of that disturbance). If a disturbance occurs, the pixel moves along the designated pathway. The pixels that remain in the class at the end of the age range for that class are then affected by succession.

Attributing the Main Succession Pathway

- Double-click on the box you wish to attribute to open the *Class Properties* dialogue box (Figure 5.2). Note that there are two levels to this dialogue box: the top shows deterministic transitions (i.e. succession) and the bottom shows probabilistic transitions (i.e. disturbances).

- For deterministic transitions, edit the <u>Start Age</u> to reflect the average starting age for this developmental stage. For the early-development class (A) this will always be 0 years. For other classes enter the average beginning age for that stage of development across the BPS.

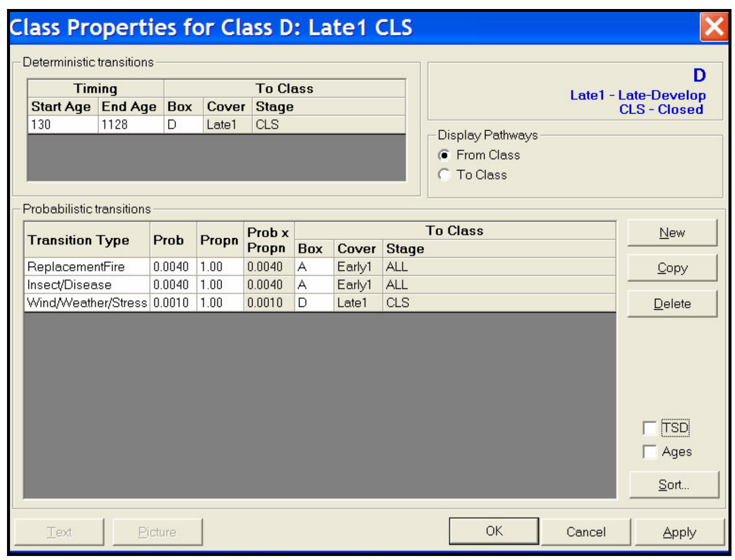


Figure 5.2: Class Properties dialogue box. The name (D), cover type (Late1 – Late-Develop), and structural class (CLS - Closed) is shown in the upper right. The deterministic transition (i.e. main succession pathway) is shown in the upper left. The probabilistic transition pathways (i.e. disturbance pathways) are shown at the bottom.

[16] ESSA Technologies Ltd. 2005. Vegetation Dynamics Development Tool User's Guide, Version 5.0. Prepared by ESSA Technologies Ltd., Vancouver, BC. 177 pp.

- Edit the End Age to reflect the ending age of the class.

- Edit the To Class box to reflect the dominant pathway of change for this BPS. Succession will follow one of these pathways:
    - *Maintenance*. The dominant change (To Class) pathway acts to maintain a class (e.g. D to D or E to E). This typically only happens in the late-development classes.
    - *Transition*. The dominant change (To Class) follows a path towards a later developmental stage. The transition can take you either:
        - Toward a closed structural class (e.g. A to B to E). This is the typical succession pathway in systems with infrequent fire or slow growth
        - Toward an open structural class (e.g. A to C to D). This is the typical succession pathway in systems with frequent surface or mixed fire disturbances that maintain the open structure and promote the development of the upper vegetation layer to a later (older) stage.

The *End Age* of one box should generally line up with the *Start Age* of the next class in the succession pathway. For example, if your pathway goes from B to E and if B ends at 99, E should start at 100.

Attributing Alternative Succession Pathways

Alternative succession pathways can be attributed one of two ways: as probabilistic transitions (i.e. disturbance) or as occurring only in the absence of another disturbance (e.g. fire) using Time Since Disturbance (TSD). The decision matrix in Figure 5.4 may help you determine how to attribute alternative succession pathways.

Alternative Succession as a Probabilistic Transition

Alternative succession is generally treated as a probabilistic transition in systems with infrequent fire.

- Double-click on the box you wish to attribute to open the *Class Properties* dialogue box (Figure 5.2). Note that there are two levels to this dialogue box: the top shows deterministic transitions (i.e. succession) and the bottom shows probabilistic transitions (i.e. disturbances).

- Add Alternative Succession to the probabilistic transitions by clicking on the New button and selecting AltSuccession from the Transition Type drop-down menu. Note that you can add more than one alternative succession pathway; just add AltSuccession multiple times to your box and select different pathways for each.

- Define the alternative succession pathway under the To Class column (i.e. to which box does the alternative succession send a pixel).

- Enter a probability in the Prob column. Probabilities are the inverse of years (probability = 1/annual frequency). Table 5.4 is a quick reference of years and associated probabilities.

Alternative Succession in the Absence of Another Disturbance (TSD)
In most BpS that are fire maintained (e.g. Fire Regime Group I, II, and sometimes III), the main succession pathway (i.e. deterministic transition) will be towards open canopy classes. In these classes, any kind of alternative succession will happen only in the *absence* of fire. We can use Time Since Disturbance (TSD) to control the movement of pixels based on the time since a disturbance.

For example, in the fire maintained BpS shown in the standardized 5-box model in Figure 5.3, class D is a late-development state, maintained in an open condition by periodic surface fire. If several fire return intervals are missed, class D will transition to class E, a late-development, closed state, through alternative succession. In other words, for the open, late-development class (D) to develop into the closed, late-development class (E), there must be no fires for at least 40 years. Or, in order for a type D to become a type E, at least four 10-year fire cycles must be missed. Figure 5.4 is a dichotomous key that will help you determine when to use TSD.

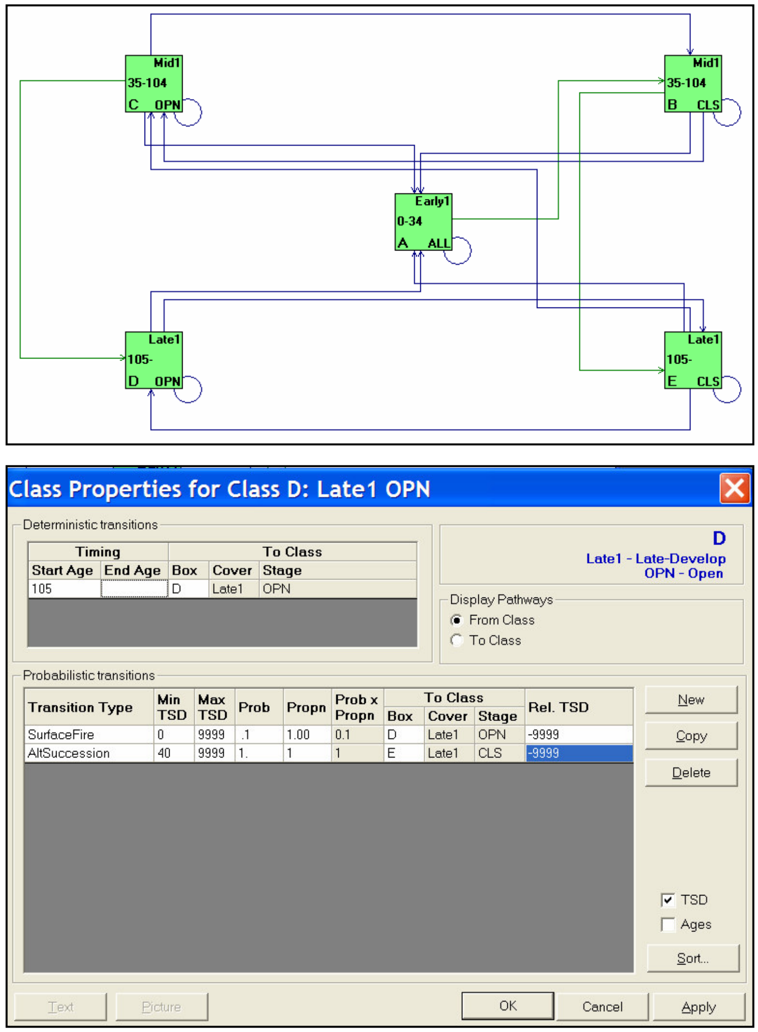


Figure 5.3: Alternative succession can be used to model transitions that occur in the absence of disturbance.

Attributing Alternative Succession

- Double-click on the box you wish to attribute to open the *Class Properties* dialogue box (Figure 5.2). Note that there are two levels to this dialogue box: the top shows deterministic transitions (i.e. succession) and the bottom shows probabilistic transitions (i.e. disturbances).

- Add Alternative Succession to the probabilistic transitions by clicking on the New button and selecting AltSuccession from the Transition Type drop-down menu. Note that you can add more than one alternative succession pathway; add AltSuccession multiple times to the *Class Properties* dialogue box and select different pathways for each.

- Display the TSD column by clicking in the TSD box at the bottom right of the dialogue box.

- Enter a number in the Min TSD column that reflects the amount of time it would take in the absence of fire to advance in age from one class to another. You may also want to think about this in terms of number of fire cycles missed.

- Enter a probability of 1 for AltSuccesion. This tells the model that a pixel will always move to the specified class if the time since disturbance reaches the specified number of years. For example, if you attribute a model so that a pixel will move from D to E when TSD is 40 under a probability of 1 (and select AllFire as the Time Since Disturbance Group for AltSuccssion), all pixels left after 40 years that have not experienced a fire during those 40 years will advance to E.

- When you run the model, be sure to attribute the TSD groups correctly. Go to Run—Settings and select the *Options* tab. Click on the Select button to the right of Use Time Since disturbance to open the *Time Since Disturbance Groups* dialogue box. For the transition type AltSuccession, select AllFire from the Associated TSD Group dropdown menu.

Attributing Disturbances

Disturbance (i.e. probabilistic transitions) can only cause transitions that (a) maintain a class or (b) reduce the age of a class. Disturbance cannot advance the age of a class (i.e. fire cannot change pixels from class mid-development C or B to late-development D or E)—only succession or alternative succession can advance the age of a class.

1. Double-click on the box you wish to attribute. The *Class Properties* dialogue box appears (Figure 5.2). Note that there are two levels to this dialogue box: the top shows deterministic transitions (i.e. succession) and the bottom shows probabilistic transitions (i.e. disturbances).

2. Add disturbances by clicking the New button and picking the disturbance from the Transition Type drop-down menu. Disturbances used in the LANDFIRE are defined (and grouped hierarchically) as shown in Table 5.5.

3. Define the pathway this disturbance causes under the To Class column (i.e. which box does the disturbance send a pixel to). Note that disturbances can have multiple pathways; just add the same disturbance twice to your box and select a different pathway for each.

4. Edit probabilities as necessary under the Prob column. Probabilities are the inverse of years (probability = 1/annual frequency). Table 5.4 is a quick reference of years and associated probabilities. As a general rule, include only disturbances that would have a noticeable effect on the model. For disturbances that you want to include, but might have minimal effects, use a probability of 0.001.
5. The proportion (Propn) field should always have a value of one for LANDFIRE models. This is the default value and modelers should not need to change it. For more information about using the proportion function, refer to the *VDDT User's Guide*[17].

[17] ESSA Technologies Ltd. 2005. Vegetation Dynamics Development Tool User's Guide, Version 5.0. Prepared by ESSA Technologies Ltd., Vancouver, BC. 177 pp. Available at: www.essa.com.

6. Delete a disturbance by deleting the letter (A-E) in the ToClass box.

Table 5.4: Years (frequency) and associated probabilities. Probability is the inverse of frequency.

Year Value	Probability	Year Value	Probability	Year Value	Probability
2	0.500	50	0.020	130	0.008
5	0.200	60	0.017	150	0.007
10	0.100	66	0.015	200	0.005
20	0.050	75	0.013	250	0.004
25	0.040	80	0.013	300	0.003
30	0.033	85	0.012	500	0.002
33	0.030	100	0.010	700	0.001
40	0.025	110	0.009	1000	0.001

Using Relative Age

- In LANDFIRE models, we will NOT use the KeepAge function to maintain consistency. The KeepAge column should always be set to False. For more information about the Keep Age function, refer to the *VDDT User's Guide*.

- In LANDFIRE models, RelAge (Relative Age) will always be 0, except when you have Replacement Fire in class A (or other disturbances that cause top-kill in a class that starts at age 0). To use RelAge in A to A replacement disturbances:

  1. Double-click box A to open its attributes.

  2. Click in the Ages box at the lower right. This expands the probabilistic transitions portion of the window to include the RelAge and KeepAge columns.

  3. Find the replacement fire disturbance that maintains the class.

  4. In the RelAge column, enter –n, where n is the number of timesteps a pixel can stay in that class (this should be the number you entered in the End Age box for the deterministic transition). For example, if a pixel moves from A to C in 40 timesteps under succession (i.e. deterministic transition), but you may maintain A with a replacement fire; enter –40 in relative age (RelAge) on the line showing A to A replacement fire. If you do not use relative age (RelAge), the age of the pixel is not reset to the class beginning age and the disturbance has no effect. By using relative age (RelAge), every pixel affected by the disturbance will be reset to the class beginning age. If –n is greater than the age of the pixel, the model does not set the age to a negative age or to an age younger than the beginning age of the class, but sets the age to the beginning age of the class (usually 0 for class A).

Table 5.5: Disturbances used in LANDFIRE models and their hierarchical groupings.

Group	Sub-Group	Disturbance Type	Description
All Fire			All fires grouped together for graphing purposes.
	Replacement Fire		Fires that replace the existing vegetation type.
		Replacement Fire	Fires with >75% top-kill. These fires will always replace the existing vegetation type and reset the pixel to class A. You should attribute all events of this type to reset the pixel to class A.
	Non-Replacement Fire		Fires with <75% top-kill, grouped together for graphing purposes.
		Mixed Fire	Mixed severity fires with 25-75% top-kill.
		Surface Fire	Surface fires with less than 25% top-kill.
Non-Fire Disturbances			Disturbances other than fire grouped together for graphing purposes.
		Competition/ Maintenance	Competition and/or lack of seed source maintain your class. This will always be a type that keeps you in a class.
		Insects/ Disease	Insects or disease.
		Wind/ Weather/ Stress	Drought, wind disturbance, and other weather disturbances.
		Native Grazing	Grazing by native animals.
	Optional Types	**Optional 1** **Optional 2**	Optional disturbances that are either (a) not included in the categories above or (b) should be singled out from a larger group when data allows. Clearly define and describe optional disturbances in the model documentation.
Alternative Succession		**Alternative Succession**	Alternative succession pathway that is different from the primary pathway. Alternative succession can be modeled as a probabilistic transition (i.e. disturbance) or using TSD (Time Since Disturbance). See *Attributing Alternative Succession Pathways* in Chapter 6.

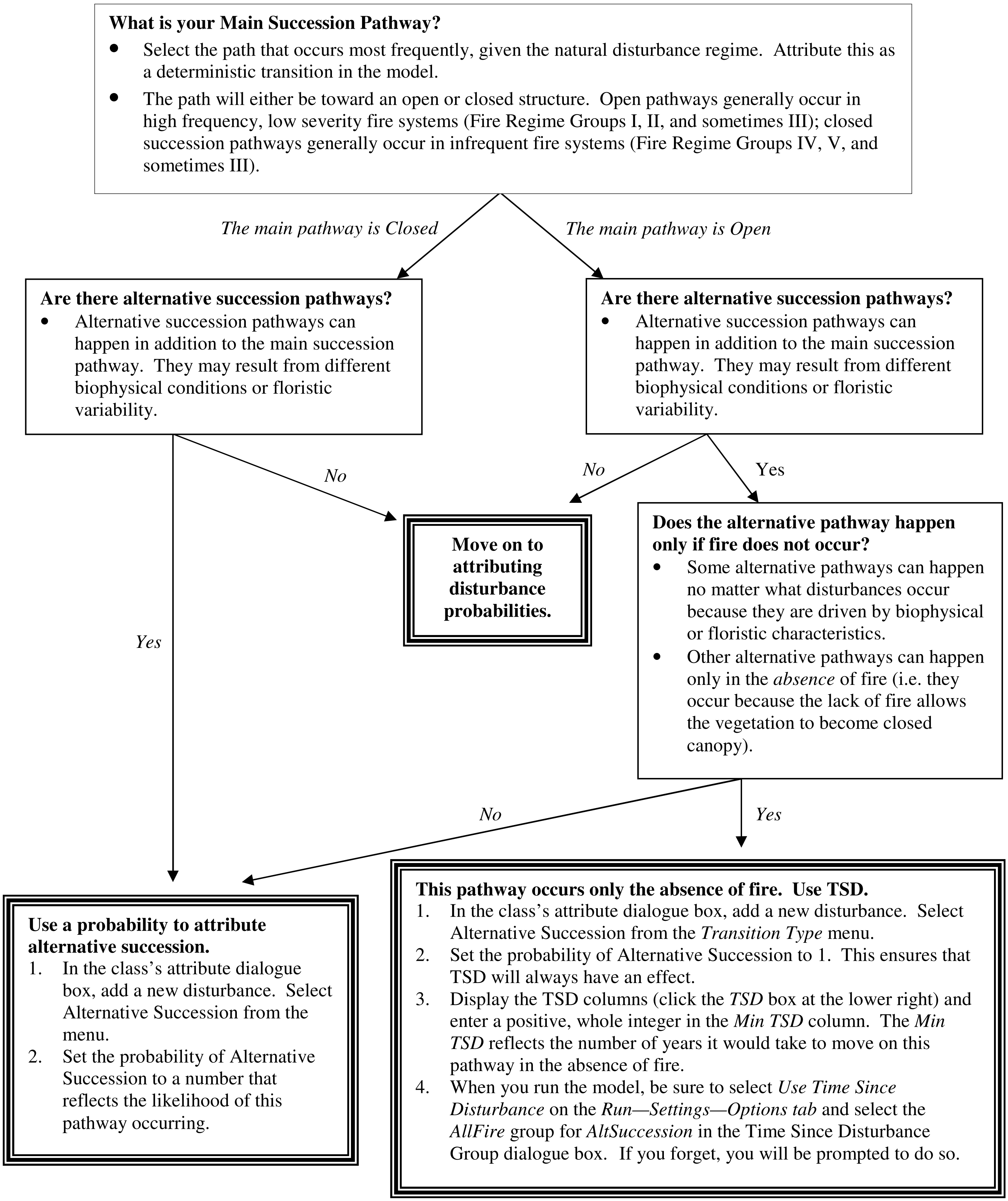


Figure 5.4: Decision matrix for attributing succession. Use this flow-chart to help you determine how to attribute alternative succession pathways.

Running the Model

See Table 5.6 and the Cheatsheet in *Appendix G* for a quick-guide to running a model.

1. Edit the run settings. Go to Run—Settings to open the *Run Settings* dialogue box (Figure 5.4).

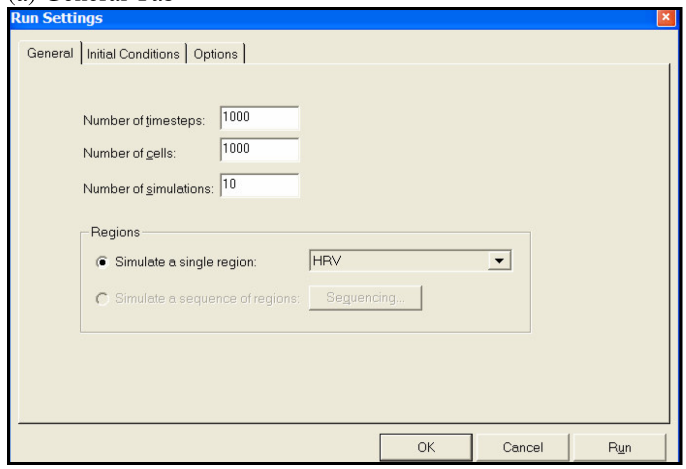
2. On the *General* tab set the Number of timesteps and Number of cells to 1000. Set the Number of simulations to 10. This will simulate 1000 pixels for 1000 years in 10 Monte Carlo simulations (Figure 5.5a).

3. On the *Initial Conditions* tab set the Total area represented to 1000. Note: by setting the number of cells and the total area represented to 1000, you are telling the model that each pixel represents one unit of area. Click the Normalize button to distribute the number of pixels evenly throughout your classes. Click on the Randomize initial TSD to a maximum of box (if applicable) and enter the value of the maximum TSD used in your model (Figure 5.5b).

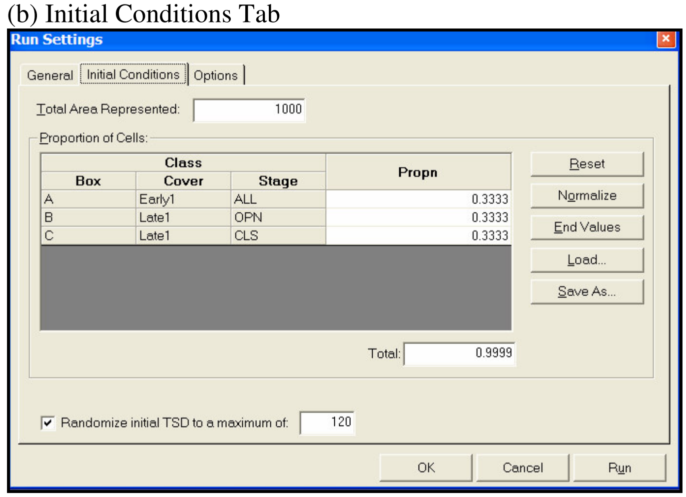
4. On the *Options* tab select Use Time Since Disturbance (if applicable). Click on the Select button to the right of Use Time Since Disturbance to open the *Time Since Disturbance Groups* dialogue box. For the AltSuccession Transition Type, select AllFire as the Associated TSD Group from the dropdown menu (Figure 5.5c). Click OK to exit the *Time Since Disturbance Groups* dialogue box. Note: alternatively, you could specify AllFire as the Associated TSD Group for AltSuccession under File—Properties—TSD Group.

Figure 5.5: Run Settings dialogue box.

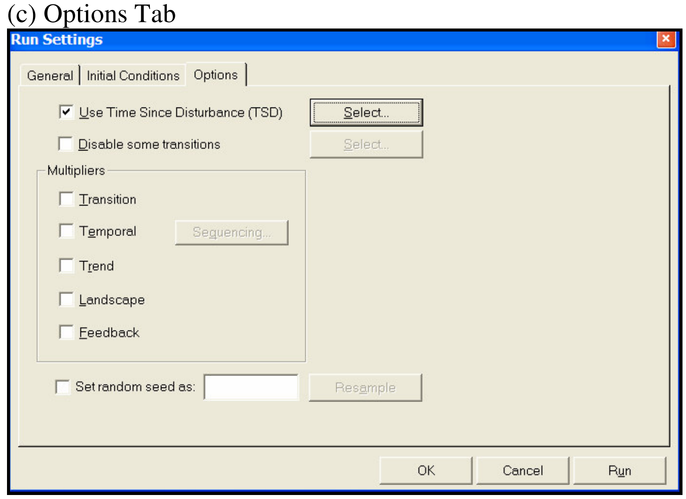
(a) General Tab



(b) Initial Conditions Tab



(c) Options Tab



5. Run the model. Select the Run button at the bottom of the *Run Settings* dialogue box OR Start Model from the Run menu.

Table 5.6: Quick Guide to Running a Model

Step	***Function***	***LANDFIRE Model Guidelines***
1	*Open Run Settings dialogue box…………………*	Select Settings from the run menu
2	*Time Definitions (General Tab)*	
	• Number of timesteps………………………	1000
	• Number of cells…………………………….	1000
	• Number of simulations…………………….	10
3	*Initial Conditions (Initial Conditions Tab)*	
	• Total area represented…………………	1000
	• Proportion of cells………………………	Normalize
	• Randomize initial TSD to a maximum of..	Value of the max TSD used in your model (if applicable)
4	*Time Since Disturbance (Options Tab)*	
	• TSD…………………………………………	Use if applicable.
	• TSD group…………………………………	Select All fire for the appropriate transition types.
5	*Run Model……………………………………………*	Click the Run button from the *Run Settings* dialogue box OR Start Model from the Run menu.

Viewing Results

1. Change the way data will be displayed under Results—Graph Options. Recommended graphing options are:
   - Click on Same y-axis. Always leave this option checked on.
   - Set Graphing Years at intervals you'd like to see in individual bar graphs (e.g. 1 and 1,000 for Time Graphs and 0, 100, 300 and 500 for Bar Graphs).
   - Select Show avg, min, max to display these values.
   - Select Show mean line—For avg. only and enter the timesteps you'd like to see a meanline for (e.g. 100 and 500).

2. To view the **percent of the landscape in each class**:
   - Go to Results—End Values. The table shows the percent in each class at the end of your run. *OR*
   - Go to Results—Bar—Class. The bar graph shows the percent of the landscape (y-axis) in each class (x-axis). *OR*
   - Go to Results—Time—Class. Enter up to four classes to view. The line graphs show the percent of the landscape (y-axis) in each class (individual graphs) over time (x-axis).

> If your graph displays points and you want to see bars, go to *Results-Graph Options* and uncheck *Show avg, min, max.*

3. To view the **probability of fire and other disturbances**:
   - Go to Results—Time—Transitions. Select up to four transitions (i.e. disturbances) to view.
   - The line graphs show the percent of the landscape (y-axis) that was affected by each disturbance (individual graphs) over time (x-axis).
   - To convert the percent of the landscape affected by the disturbance (y-axis) to a probability, divide the y-axis value by 100.

> Always uncheck *All Transitions*, or one of your four graphs will show the transitions in all classes over time.

Double-Checking the Model

When the model results are acceptable, run the model again using ending values.

1. Go to Run—Settings.
2. On the *Initial Conditions* tab, click the End Values button. This will distribute the pixels into your classes based on the ending values of your last model run. You can also use these values to estimate the percentages of each structure class.
3. Click the Save Values button to save the initial conditions to a file. The values file (.ic) should automatically save into the directory with the rest of your VDDT files. Be sure to name the .ic file with the unique code of the BPS and click the Save button.
4. Click the Run button. This will be the final run of your model.

You may also want to test your model by turning fire off and seeing if the results are within your expectations.

1. Go to Run—Settings.
2. On the *Options* tab, click on Disable some transitions. Use the Select button on the right to choose AllFire (or any other disturbance you'd like to turn off). Click OK.
3. Run the model again and view the results. Be sure to go back and turn fire back on before running the model a final time.

Modeling Rules for LANDFIRE

To ensure national consistency and agreement with other LANDFIRE models, the following rules must be followed for all LANDFIRE models.

- ❒ Keep Age must always be set to false.
- ❒ Relative Age (RelAge) must always be 0, except with replacement disturbances in classes that start at age 0 (e.g. replacement fire in class A).
- ❒ Ages of classes along the main succession pathways must line up with no gaps or overlap (i.e. be mutually exclusive).
- ❒ Time Since Disturbance (TSD) can only be used with Alternative Succession (AltSuccession) and with a probability of 1.
- ❒ Alternative Succession (AltSuccession) can be used with or without TSD. If TSD is used, the rule above applies.
- ❒ Disturbances (except AltSuccession) cannot advance a pixel in age (i.e. disturbances can only maintain you within a class or send you to a younger class).
- ❒ The same disturbance can be used twice in a single class only if its destination classes are different.

Modeling Tips

→ Use the Cheatsheet (*Appendix G*) to help you remember modeling standards.

→ Use the worksheet (*Appendix H)* to track the changes you make as you model.

→ Expect to do several model runs. Don't strive for perfection until you've run the model at least 10 times—it will improve (as will your understanding of its sensitivity) with iterations.

→ Use the mean fire frequency as your first input to the model. Adjust other disturbances later.

- → Start by inputting the mean fire frequency (as a probability) in every class (box). For example, replacement fire may be more probable in classes B and E than others, but start with an even distribution and tweak the model later. Go back to change the distribution of fire throughout the classes, if necessary.

- → It is helpful to think about disturbance probabilities comparatively. For example, if the probability of Insects/Disease is 0.01 and Fire is 0.10, we're saying fire occurs ten times as often as insect outbreaks (or affects 10 times more of the landscape).

- → Include only those disturbances that affect the model. You will have to run several iterations of the model to test its sensitivity to different disturbances.

- → Disturbance probabilities for fire (and other disturbance groups) are cumulative within a box. For example, surface fire, mosaic fire, and replacement fire are additive within any box.

- → Make sure that the sum of all disturbance probabilities in any given box is <1.00, otherwise each year a disturbance will occur and no pixels will be left for succession to occur.

- → To calibrate models in systems where fire exclusion is an issue today, try turning fire "off" (<u>Run Settings—Options tab—Disable some transitions</u>) and see if the results of the model change the way you'd expect them to.

- → To calibrate fire in a model, graph fire through time (<u>Results—Time—Transitions</u>). The x-axis shows the percentage of the landscape that is affected by fire (which, in LANDFIRE models, is also equal to the probability of fire). Test this number against your knowledge of how much of that type would be affected by fire.

Appendix A: Links and Additional Resources

This table highlights links to LANDFIRE and related projects and resources for modelers.

LANDFIRE www.landfire.gov	The LANDFIRE website, explaining the project's scope, objectives, and deliverables.
FRCC Guidebook (Fire Regime Condition Class) www.frcc.gov	The FRCC website, which includes explanations of the project, the entire guidebook, and descriptions of BpS modeled to-date.
VDDT (Vegetation Dynamics Development Tool) www.essa.com	The website for ESSA, the company that created VDDT. VDDT is public domain and can be downloaded from the web. User's guides, updates, and other software packages are available here.
The Coarse-Scale Spatial Data www.fs.fed.us/fire/fuelman	*The Development of Coarse-Scale Spatial Data for Wildland Fire and Fuel Management* (Schmidt et al. 2002, USDA Forest Service General Technical Report RMRS-87) was the pre-cursor to FRCC and LANDFIRE and was a first, coarse-scale attempt at mapping fire regime characteristics, including FRCC, for the entire US.
The National Fire Plan www.fireplan.gov	LANDFIRE is part of the implementation of the National Fire Plan, an interagency commitment to the rehabilitation and restoration of fire-adapted ecosystems, among other goals.
The Nature Conservancy's Global Fire Initiative http://nature.org\initiatives\fire	The Nature Conservancy's Fire Initiative was designed to address the threat of altered fire regimes on both public and private lands. TNC is taking a leading role in the development of vegetation dynamics models in the LANDFIRE project.
The Missoula Fire Sciences Laboratory www.firelab.org	The Fire Lab, a division of the USDA Forest Service Rocky Mountain Research Station, is the scientific and methodlogical leader in the LANDFIRE project.
EROS Data Center http://edc.usgs.gov	USGS's Earth Resources Observation and Science Data Center leads the vegetation data collection in LANDFIRE.
FEIS: Fire Effects Information System www.fs.fed.us/database/feis	FEIS is a searchable database containing summaries of fire effects, fire ecology, and botanical characteristics of species in North America. Summaries are updated regularly and provide excellent baseline information and literature reviews.
Wildland Fire in Ecosystems: Effects of Fire on Flora www.fs.fed.us/rm/pubs/rmrs_gtr42_2.html	This publication is part of the Rainbow Series and contains regional summaries of fire history and effects for ecological systems in the United States. It provides broad information and literature reviews.
NRCS PLANTS Database http://plants.usda.gov/	A catalogue of North American plant species and the species codes used in LANDFIRE.

Appendix B: Letters of Support from Federal Land Management Agencies

File Code: 5100 **Date:** July 29, 2004
Route To: (2400), (4000), (5100)

Subject: Introduction of Interagency Fire, Ecosystem, and Fuel Assessment Mapping Project, LANDFIRE

To: Regional Foresters, Station Directors, Area Director, IITF Director, and WO Staff

LANDFIRE is a five-year, $40 million interagency partnership sponsored by the Wildland Fire Leadership Council involving the Forest Service, the Department of the Interior, including the Bureau of Land Management, National Park Service, Fish and Wildlife Service, Bureau of Indian Affairs, and U.S. Geological Survey. The Nature Conservancy is also a major partner and several other agencies are making contributions as well.

The LANDFIRE project integrates reference data, satellite imagery, and models of fire and vegetation dynamics. LANDFIRE will generate nationally consistent, mid-scale maps and digital geospatial data of vegetation characteristics and condition, fire behavior and effects, fuels models, historical fire regimes, and fire regime condition class at the landscape level.

The success of LANDFIRE is considered critical to the National Fire Plan, the Healthy Forests Initiative, and implementation of the Healthy Forests Restoration Act. It will help land managers identify priority areas for reduction of wildfire risks and to identify and facilitate restoration of forest, shrub, and grass ecosystems.

At the heart of LANDFIRE lies a reference database containing geo-referenced field data describing vegetation, fire, and fuels. The project relies heavily upon existing inventory, monitoring, and research programs for these data. Assistance from field units and managers is critical to ensure that the best data and science are incorporated into the LANDFIRE project.

Thank you for your efforts in supporting the LANDFIRE project. If you would like to learn more about LANDFIRE, please visit www.landfire.gov.

/s/ Sally Collins (for)
DALE N. BOSWORTH
Chief

cc: fire directors

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Washington, D.C. 20240

July 30, 2004

In Reply Refer To:
9211 (FA100) I

EMS TRANSMISSION 08/05/2004
Information Bulletin No. 2004-127

To: AFOs
Attn: State Fire Management Officers

From: Director

Subject: Status of Interagency LANDFIRE Project

LANDFIRE is a five-year, $40 million interagency partnership sponsored by the Wildland Fire Leadership Council involving the Forest Service and the Department of the Interior, including the Bureau of Land Management, National Park Service, Fish and Wildlife Service, Bureau of Indian Affairs, and U.S. Geological Survey. The Nature Conservancy plays an important role, and other federal and state research institutions also contribute.

The purpose of LANDFIRE is to generate the nationally consistent spatial data and predictive models needed by land and fire managers to prioritize, evaluate, plan, complete and monitor fuel treatment and restoration projects, and can be applied to decision making for wildland fire management. The success of this project is essential for achieving the goals of the National Fire Plan, Healthy Forests Initiative and implementation of the Healthy Forests Restoration Act.

The LANDFIRE project integrates satellite imagery, models of fire and vegetation dynamics, and field data. Products will include landscape scale maps and digital geo-spatial data of existing vegetation, biophysical settings, current fuel loadings, historical fire regimes and Fire Regime Condition Class (indices of departure from historical fire regimes). These products are ideal for regional planning and can be stepped down to complement finer scale mapping efforts and assist local planning.

Potential applications of the LANDFIRE deliverables include improved risk assessments, fire behavior predictions, treatment prioritization and integration with Land Health Standards. Land Use Plans, Fire Management Plans and project plans can all benefit from these products. In summary, LANDFIRE data layers will augment and strengthen local information for a wide range of fire and fuels applications.

A fundamental element of LANDFIRE is a database containing geo-referenced field data describing vegetation and fuels. The project relies heavily upon data from existing inventory, monitoring and research projects. Assistance from knowledgeable staff at LANDFIRE workshops is critical to ensure that the best data and science are incorporated into the project. This participation will ensure that Bureau lands are accurately represented in the final mapping and data layers.

Thank you for your efforts in supporting LANDFIRE. If you would like to learn more about LANDFIRE, please visit www.landfire.gov or contact Melanie Miller, Planning and Resources (FA-620) at 406-829-6941.

Signed by:
Francis R. Cherry, Jr.
Acting Director

Authenticated by:
Barbara J. Brown
Policy & Records Group, WO-560

In Reply Refer To:
FWS/ANRS-NR-FM/018582

Memorandum

To: Regional Directors, Regions 1-7
Manager, California/Nevada Operations Office
Refuge Chiefs, Regions 1-7 and CNO

From: Assistant Director - National Wildlife Refuge System
/s/ William Hartwig August 31, 2004

Subject: LANDFIRE

LANDFIRE is a five-year, $40 million interagency partnership sponsored by the Wildland Fire Leadership Council involving the Department of the Interior (including the Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, Bureau of Indian Affairs, and U.S. Geological Survey) and the USDA Forest Service. The Nature Conservancy is also a major partner and several other agencies are making contributions as well.

The LANDFIRE project integrates reference data, satellite imagery, and models of fire and vegetation dynamics. Nationally LANDFIRE will generate consistent, mid-scale maps and digital geospatial data of vegetation characteristics and conditions, fire behavior and effects, fuels models, historical fire regimes, and fire regime condition class at the landscape level.

The success of LANDFIRE is considered critical to the National Fire Plan, the Healthy Forests Initiative, and implementation of the Healthy Forests Restoration Act. It will help land managers identify priority areas for reduction of wildfire risks and to identify and facilitate restoration of forest, shrub, and grass ecosystems.

At the heart of LANDFIRE lies a reference database containing geo-referenced field data describing vegetation, fire, and fuels. The Service's fire program, as well as many natural resource programs, should find this database very valuable for planning and incident management. In addition to vegetation and biophysical data layers at a 30-meter resolution, the database will contain spatial and 18 years of daily weather data necessary for running the FARSITE program (Fire Area Growth Simulation Model).

LANDFIRE relies on a reference database containing geo-referenced field data describing vegetation, fire, and fuels. The project relies heavily upon existing inventory, monitoring, and research programs for this data. Assistance from field units and managers is critical to ensure that the best data and science are incorporated into the LANDFIRE project. The LANDFIRE project will also need knowledgeable staff at LANDFIRE vegetative modeling workshops, and support of LANDFIRE field sampling crews. This participation will ensure accurate representation of your area in the final products.

Thank you for your efforts in supporting the LANDFIRE project. If you would like to learn more about LANDFIRE, please visit www.landfire.gov.

Cc: 3251-MIB-FWS/ANRS
670-ARLSQ-FWS/ANRS-DNRS
670-ARLSQ-FWS/ANRS-OIM
570-ARLSQ-FWS/ANRS-NR
570-ARLSQ-FWS/ANRS-NR-FM
Regional Fire Management Coordinators 1-7 & CNO

FWS/ANRS-NR-FM:BLeenhouts:kem:8/24/04:703-358-2043
S:\Control Correspondence\2004\018582.doc

Appendix C: Peer Review Form

1. Save this form with your last name and the 4-digit BPS ID number. Go to *File—Save As* and enter: *Name_BPS#*.doc.

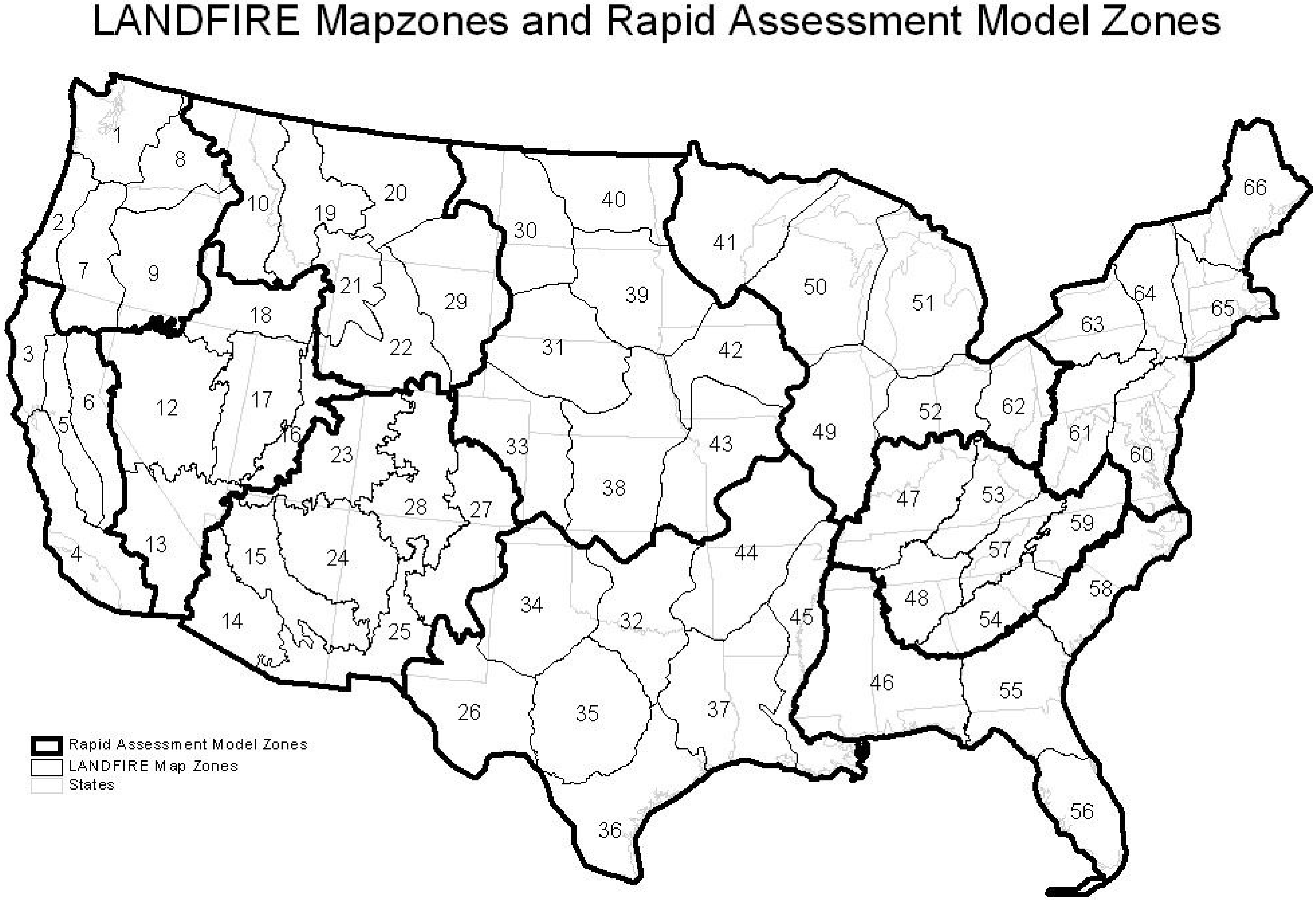
2. Basic Information		
Date of review:	**Map Zone(s):**	
BPS name:	**BPS code (4-digit):**	
Name:	**Title:**	
Affiliation:	**Address:**	
City:	**State:**	**Zip:**
Phone:	**Email:**	
Anonymity: (select one)	☐ **I would like my name listed as a reviewer.** If you select this option, your feedback will be incorporated and your name will be listed on the BPS description as a reviewer.	
	☐ **I would like to be an anonymous reviewer.** If you select this option, your feedback will be incorporated and only the regional lead and national staff will know your name.	

3. Rank your knowledge of this BPS.			
	Expert[a]	**Knowledgeable**[b]	**Familiar**[c]
a) How would you rate your understanding of the **fire regime** of this BPS throughout the entire model zone?	☐	☐	☐
b) How would you rate your understanding of the **succession processes** of this BPS throughout the entire model zone?	☐	☐	☐
c) How would you rate your understanding of the **composition and structure** of this BPS throughout the entire model zone?	☐	☐	☐
d) If your knowledge of this BPS varies considerably **geographically**, please indicate how it may vary within or between mapping zones (see map below). Leave blank if there is no substantial variation.			

[a]*Expert*: **In this BPS**, you have directed research or have at least 5 years of field experience, **and** feel confident in your understanding of the vast majority of related fire and/or other literature published in major professional journals.

[b]*Knowledgeable*: **In this BPS**, you have participated in research or have at least 3 years of field experience, **and** are familiar with some related fire and/or other literature published in major professional journals.

[c]*Familiar*: **In this BPS**, you have not directly participated in research and have less than 3 years field experience, but feel confident in your understanding of the majority of related fire and/or other literature published in major professional journals.


LANDFIRE Mapzones and Rapid Assessment Model Zones
Rapid Assessment Model Zones
LANDFIRE Map Zones
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4. Determine how you will perform your review. Reviews can be performed via interactively modeling in VDDT (optional but preferred), or via review of BPS descriptions. If you choose to use VDDT software to review the models, ensure that you attribute the time definitions with at least 500 years (time steps), and use 10 Monte Carlo simulations.		
	Review of BPS descriptions and the actual VDDT model	**Review of BPS descriptions only**
I performed this review via	☐	☐

5. Review the BPS description and model inputs, and answer the following questions.
If you do not know the answer to any of the following questions, please enter "do not know". Assume that the reference fire regime and vegetation/fuels input and described for each BPS reflect historic conditions (i.e., pre-European settlement); and expected conditions if a natural fire regime were allowed to operate freely. Burning by Native Americans may or may not be considered part of the natural fire regime. Models are NOT intended to include states or processes that result from human-induced disturbances or management actions (except possibly Native American burning), and are constrained by the standardized model structure for this project (i.e., 3-5 classes (boxes) per model).

5a. Rank this model overall.
Check one box for each row to classify your review overall. If you reject the model outright, please explain in further detail below.

	Accept as-is	**Needs minor editing**	**Needs major editing**	**Reject outright**
Model Description	☐	☐	☐	☐ **Model is redundant with another BPS (please specify):** ☐ **Model is not well-thought out or researched, for the reasons explained in the questions below.** ☐ **Other:**
VDDT Model	☐	☐	☐	

Introduction and Description
The introductory BPS descriptions are intended to briefly describe the key factors that set this BPS apart from other BPSs. It should describe the geographic extent, biophysical site (e.g., major landform position, geologic substrate, elevation range), the vegetation, disturbance regimes, common adjacent BPSs, and information about scale.

5b.	Do the **introductory descriptions** adequately capture its distribution across the model zone? If not, what **specifically** should be added or removed from this description?	

Mosaic of model classes A-E Model outputs summarizing the expected proportion of each of the reference model classes (A-E) in the BPS reflects the result of successional and disturbance processes operating concurrently over the long term.		
5c.	Do the model **class descriptions** (A-E) appear to encompass the full spectrum of reference classes (including species composition, lifeform description, and canopy position) within the context of the standardized model structure (e.g., 3- to 5-box model)?	
5d.	Do the **structure data** described for each class (A-E) appear to be accurate, including percent cover and height of the upper layer lifeform, and tree size class (if applicable)?	
5e.	Do the **proportions of classes A-E** appear to reflect the landscape scale mosaic for this BPS ($\pm$ 10% for any one class) given a historic or reference fire regime?	If No, please select one option: ☐ The proportions are inaccurate for the entire geographic area this model covers and the model should be rejected and remodeled. Please complete additional questions above so that we know how to remodel this type. ☐ The proportions are inaccurate for a subset of the geographic area this model covers, including these areas:

Disturbance Inputs Disturbance frequencies are translated to annual probabilities (1/ frequency in years) when entered into the VDDT model. Each disturbance can operate with different frequencies (i.e., different probabilities) and cause different transitions (i.e., have different effects) in different classes (i.e., boxes A-E). Fire disturbances are categorized in three severity classes (surface = <25% top-kill; mixed = 25-75% top-kill; replacement = >75% top-kill). Additional disturbance types may be modeled.		
5f.	Does the **range in fire frequency** (fire return intervals) adequately capture the best available information for the BPS described?	

5g.	Are there **sources of published literature on fire frequency** that appear to be missing and which will change the range or central tendency of fire frequency used in the model if it were included? If so, provide the full citation of literature that should be considered.	
5h.	If you review the VDDT model, do the **differences in annual fire probabilities for each fire severity type by class** appear to capture the best available information on how fire frequency and type are distributed throughout this BPS? If not, specifically what should be changed within the model?	
5i.	Does the **distribution of fire severity** between stand replacement (>75% top-kill), mixed severity (25-75% top-kill) and surface (<25% top-kill) fire regimes adequately capture the best available information for the BPS described?	
5j.	Are there **sources of published literature on fire severity** that appear to be missing and which will change the distribution of fire severity used in the model if it were included? If so, provide the full citation of literature that should be considered.	
5k.	Are there any major **non-fire related disturbances** (e.g., hurricanes, insects) that have not been captured by the model? If so, what are they? For each, what would you estimate are their mean, minimum and maximum return intervals and severities (e.g., stand replacement, mosaic)? Which classes (A-E) do each operate in?	

Additional Feedback		
5l.	Other comments, suggestions, or feedback.	

When complete, please email this form to your regional lead.

THANK YOU FOR COMPLETING THE MODEL REVIEW!

Appendix D: Draft Biophysical Settings Legend of Ecological Systems

Western U.S. Draft Biophysical Settings Legend

Ecological System Name *	BpS Code	NatureServe Code
Barren		
Inter-Mountain Basins Sparsley Vegetated Systems	1001	CES304.618
Colorado Plateau Mixed Bedrock Canyon and Tableland	1001	CES304.765
Columbia Plateau Ash and Tuff Badland	1001	CES304.081
Inter-Mountain Basins Active and Stabilized Dune	1001	CES304.775
Inter-Mountain Basins Cliff and Canyon	1001	CES304.779
Inter-Mountain Basins Playa	1001	CES304.786
Inter-Mountain Basins Shale Badland	1001	CES304.789
Inter-Mountain Basins Volcanic Rock and Cinder Land	1001	CES304.791
North Pacific Active Inland Dune	1001	CES204.861
Mediterranean California Sparsley Vegetated Systems	1001	CES206.619
Central California Coast Ranges Cliff and Canyon	1002	CES206.903
Klamath-Siskiyou Cliff and Outcrop	1002	CES206.902
Mediterranean California Alpine Bedrock and Scree	1002	CES206.899
Mediterranean California Coastal Bluff	1002	CES206.906
Sierra Nevada Cliff and Canyon	1002	CES206.901
Southern California Coast Ranges Cliff and Canyon	1002	CES206.904
North American Alpine Ice Field	1003	CES300.728
North American Warm Desert Sparsely Vegetated Systems	1004	CES302.620
North American Warm Desert Active and Stabilized Dune	1004	CES302.744
North American Warm Desert Badland	1004	CES302.743
North American Warm Desert Bedrock Cliff and Outcrop	1004	CES302.745
North American Warm Desert Pavement	1004	CES302.750
North American Warm Desert Playa	1004	CES302.751
North American Warm Desert Volcanic Rockland	1004	CES302.754
Northwestern Great Plains Canyon	1341	CES303.658
Pacific Coast Marsh Systems	1163	CES206.617
Temperate Pacific Freshwater Mudflat	1163	CES200.878
Pacific Coastal Dunes and other Sparsely Vegetated Systems	1005	CES206.621
Mediterranean California Northern Coastal Dune	1005	CES206.907
Mediterranean California Southern Coastal Dune	1005	CES206.908
North Pacific Maritime Coastal Sand Dune	1005	CES200.881
Temperate Pacific Intertidal Mudflat	1005	CES204.879
Rocky Mountain Alpine Bedrock and Scree	1006	CES306.809
Rocky Mountain Cliff, Canyon and Massive Bedrock	1006	CES306.815
Western Great Plains Sparsely Vegetated Systems	1007	CES303.623
Southwestern Great Plains Canyon	1007	CES303.664
Western Great Plains Badlands	1007	CES303.663
Forest and Woodland		
California Coastal Redwood Forest	1015	CES206.921
California Montane Jeffrey Pine Woodland	1031	CES206.918

Central and Southern California Mixed Evergreen Woodland	1014	CES206.920
Colorado Plateau Pinyon-Juniper Woodland	1016	CES304.767
Columbia Plateau Western Juniper Woodland and Savanna	1017	CES304.082
Crosstimbers Oak Forest and Woodland	1308	CES205.682
East Cascades Mesic Montane Mixed-Conifer Forest and Woodland	1018	CES204.086
East Cascades Oak-Ponderosa Pine Forest and Woodland	1060	CES204.085
Great Basin Pinyon-Juniper Woodland	1019	CES304.773
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	1061	CES304.776
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	1062	CES304.772
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	1020	CES304.790
Klamath-Siskiyou Lower Montane Serpentine Mixed Conifer Woodland	1021	CES206.917
Klamath-Siskiyou Upper Montane Serpentine Mixed Conifer Woodland	1022	CES206.914
Madrean Encinal	1023	CES305.795
Madrean Pine-Oak Forest and Woodland	1024	CES305.796
Madrean Pinyon-Juniper Woodland	1025	CES305.797
Madrean Upper Montane Conifer-Oak Forest and Woodland	1026	CES305.798
Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland	1027	CES206.916
Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland	1030	CES206.923
Mediterranean California Mesic Mixed Conifer Forest and Woodland	1028	CES206.915
Mediterranean California Mesic Serpentine Woodland and Chaparral	1034	CES206.928
Mediterranean California Mixed Evergreen Forest	1043	CES206.919
Mediterranean California Mixed Oak Woodland	1029	CES206.909
Mediterranean California Red Fir Forest	1032	CES206.913
Mediterranean California Subalpine Woodland	1033	CES206.910
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	1166	CES306.959
North Pacific Broadleaf Landslide Forest and Shrubland	1063	CES204.846
North Pacific Dry Douglas-fir Forest and Woodland	1035	CES204.845
North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest	1174	CES204.098
North Pacific Hypermaritime Sitka Spruce Forest	1036	CES204.841
North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest	9002	CES204.842
North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	1037	CES204.001
North Pacific Maritime Mesic Subalpine Parkland	1038	CES204.837
North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	1039	CES204.002
North Pacific Mesic Western Hemlock-Silver Fir Forest	1042	CES204.097
North Pacific Mesic Western Hemlock-Yellow-cedar Forest	1040	CES204.843
North Pacific Mountain Hemlock Forest	1041	CES204.838
North Pacific Oak Woodland	1008	CES204.852
North Pacific Wooded Volcanic Flowage	1173	CES204.883
North-Central Interior Dry Oak Forest and Woodland	1311	CES202.047
North-Central Interior Maple-Basswood Forest	1314	CES202.696
Northern California Mesic Subalpine Woodland	1044	CES206.911
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	1045	CES306.805
Northern Rocky Mountain Ponderosa Pine Woodland	1053	CES306.030
Northern Rocky Mountain Subalpine Woodland and Parkland	1046	CES306.807
Northern Rocky Mountain Western Hemlock-Western Red-cedar Forest	1047	CES306.802
Northern Rocky Mountain Western Larch Savanna	1010	CES306.837
Northwestern Great Plains Highland Spruce Woodland	1048	CES303.957
Rocky Mountain Aspen Forest and Woodland	1011	CES306.813

Rocky Mountain Bigtooth Maple Ravine Woodland	1012	CES306.814
Rocky Mountain Foothill Limber Pine-Juniper Woodland	1049	CES306.955
Rocky Mountain Lodgepole Pine Forest	1050	CES306.820
Rocky Mountain Poor Site Lodgepole Pine Forest	1167	CES306.960
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	1055	CES306.828
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	1056	CES306.830
Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland	1057	CES306.819
Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland	1058	CES206.912
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	1051	CES306.823
Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland	1052	CES306.825
Southern Rocky Mountain Pinyon-Juniper Woodland	1059	CES306.835
Southern Rocky Mountain Ponderosa Pine Woodland	1054	CES306.032
Western Great Plains Dry Bur Oak Forest and Woodland	1013	CES303.667
Herbaceous		
California Central Valley and Southern Coastal Grassland	1129	CES206.942
California Mesic Serpentine Grassland	1130	CES206.943
California Northern Coastal Grassland	1131	CES206.941
Central Mixedgrass Prairie	1132	CES303.659
Central Tallgrass Prairie	1421	CES205.683
Chihuahuan Sandy Plains Semi-Desert Grassland	1133	CES302.736
Columbia Basin Foothill and Canyon Dry Grassland	1134	CES304.993
Columbia Basin Palouse Prairie	1142	CES304.792
Inter-Mountain Basins Semi-Desert Grassland	1135	CES304.787
Mediterranean California Alpine Dry Tundra	1136	CES206.939
Mediterranean California Subalpine Meadow	1137	CES206.940
North Pacific Alpine and Subalpine Dry Grassland	1171	CES204.099
North Pacific Montane Grassland	1138	CES204.100
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland	1139	CES306.040
Northern Rocky Mountain Subalpine-Upper Montane Grassland	1140	CES306.806
Northern Tallgrass Prairie	1420	CES205.686
Northwestern Great Plains Mixedgrass Prairie	1141	CES303.674
Rocky Mountain Alpine Fell-Field	1143	CES306.811
Rocky Mountain Dry Tundra	1144	CES306.816
Rocky Mountain Subalpine-Montane Mesic Meadow	1145	CES306.829
Southeastern Great Plains Tallgrass Prairie	1423	CES205.685
Southern Rocky Mountain Montane-Subalpine Grassland	1146	CES306.824
Western Great Plains Foothill and Piedmont Grassland	1147	CES303.817
Western Great Plains Sand Prairie	1148	CES303.670
Western Great Plains Shortgrass Prairie	1149	CES303.672
Western Great Plains Tallgrass Prairie	1150	CES303.673
Eastern Great Plains Wet Meadow, Prairie, and Marsh	1488	CES205.687
Pacific Coast Marsh Systems	1163	CES206.617
Mediterranean California Coastal Salt Marsh	1163	CES206.002
Temperate Pacific Brackish Marsh	1163	CES200.997
Western Great Plains Depressional Wetland Systems	1495	CES303.643

Mixed Upland and Wetland		
California Central Valley Riparian Woodland and Shrubland	1151	CES206.946
California Montane Riparian Systems	1152	CES206.610
Mediterranean California Foothill and Lower Montane Riparian Woodland	1152	CES206.944
Mediterranean California Serpentine Foothill and Lower Montane Riparian Woodland and Seep	1152	CES206.945
Inter-Mountain Basins Greasewood Flat	1153	CES304.780
North American Warm Desert Riparian Systems	1155	CES302.612
Chihuahuan-Sonoran Desert Bottomland and Swale Grassland	1155	CES302.746
Northern Rocky Mountain Avalanche Chute Shrubland	1168	CES306.801
Northwestern Great Plains Aspen Forest and Parkland	1009	CES303.681
Western Great Plains Floodplain Systems	1162	CES303.616
Northwestern Great Plains Riparian	1162	CES303.677
Western Great Plains Riparian Woodland and Shrubland	1162	CES303.956
Western Great Plains Wooded Draw and Ravine	1162	CES303.680

Shrubland		
Apacherian-Chihuahuan Mesquite Upland Scrub	1095	CES302.733
Baja Semi-Desert Coastal Succulent Scrub	1073	CES206.934
California Maritime Chaparral	1096	CES206.929
California Mesic Chaparral	1097	CES206.926
California Montane Woodland and Chaparral	1098	CES206.925
California Xeric Serpentine Chaparral	1099	CES206.927
Chihuahuan Creosotebush Xeric Basin Desert Scrub	1074	CES302.731
Chihuahuan Mixed Desert and Thorn Scrub	1100	CES302.734
Chihuahuan Mixed Salt Desert Scrub	1075	CES302.017
Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub	1076	CES302.737
Chihuahuan Succulent Desert Scrub	1077	CES302.738
Coahuilan Chaparral	1101	CES302.031
Colorado Plateau Blackbrush-Mormon-tea Shrubland	1078	CES304.763
Colorado Plateau Mixed Low Sagebrush Shrubland	1064	CES304.762
Colorado Plateau Pinyon-Juniper Shrubland	1102	CES304.766
Columbia Plateau Scabland Shrubland	1065	CES304.770
Edwards Plateau Limestone Shrubland	1393	CES303.041
Great Basin Semi-Desert Chaparral	1103	CES304.001
Great Basin Xeric Mixed Sagebrush Shrubland	1079	CES304.774
Inter-Mountain Basins Big Sagebrush Shrubland	1080	CES304.777
Inter-Mountain Basins Mat Saltbush Shrubland	1066	CES304.783
Inter-Mountain Basins Mixed Salt Desert Scrub	1081	CES304.784
Mediterranean California Alpine Fell-Field	1067	CES206.900
Mogollon Chaparral	1104	CES302.741
Mojave Mid-Elevation Mixed Desert Scrub	1082	CES302.742
North Pacific Avalanche Chute Shrubland	1083	CES204.854
North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow	1068	CES204.862
North Pacific Mesic Low Shrubland	1069	CES204.855
North Pacific Montane Shrubland	1084	CES204.087
Northern and Central California Dry-Mesic Chaparral	1105	CES206.931
Northern California Coastal Scrub	1128	CES206.932

Northern Rocky Mountain Lower Montane-Foothill Deciduous Shrubland	1106	CES306.994
Northern Rocky Mountain Subalpine Deciduous Shrubland	1169	CES306.961
Northwestern Great Plains Shrubland	1085	CES303.662
Rocky Mountain Alpine Dwarf-Shrubland	1070	CES306.810
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	1107	CES306.818
Rocky Mountain Lower Montane-Foothill Shrubland	1086	CES306.822
Sierra Nevada Alpine Dwarf-Shrubland	1071	CES206.924
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	1087	CES302.756
Sonora-Mojave Mixed Salt Desert Scrub	1088	CES302.749
Sonora-Mojave Semi-Desert Chaparral	1108	CES302.757
Sonoran Brittlebush-Ironwood Desert Scrub	1089	CES302.758
Sonoran Granite Outcrop Desert Scrub	1090	CES302.760
Sonoran Mid-Elevation Desert Scrub	1091	CES302.035
Sonoran Paloverde-Mixed Cacti Desert Scrub	1109	CES302.761
Southern California Coastal Scrub	1092	CES206.933
Southern California Dry-Mesic Chaparral	1110	CES206.930
Southern Colorado Plateau Sand Shrubland	1093	CES304.793
Tamaulipan Mesquite Upland Scrub	1391	CES301.984
Western Great Plains Mesquite Woodland and Shrubland	1111	CES303.668
Western Great Plains Sandhill Shrubland	1094	CES303.671
Wyoming Basins Low Sagebrush Shrubland	1072	CES304.794
Steppe/Savanna		
Apacherian-Chihuahuan Semi-Desert Grassland and Steppe	1121	CES302.735
California Central Valley Mixed Oak Savanna	1112	CES206.935
California Coastal Live Oak Woodland and Savanna	1113	CES206.937
California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna	1114	CES206.936
Chihuahuan Gypsophilous Grassland and Steppe	1122	CES302.732
Columbia Plateau Low Sagebrush Steppe	1124	CES304.080
Columbia Plateau Steppe and Grassland	1123	CES304.083
Inter-Mountain Basins Big Sagebrush Steppe	1125	CES304.778
Inter-Mountain Basins Juniper Savanna	1115	CES304.782
Inter-Mountain Basins Montane Sagebrush Steppe	1126	CES304.785
Inter-Mountain Basins Semi-Desert Shrub-Steppe	1127	CES304.788
Madrean Juniper Savanna	1116	CES301.730
Northern Rocky Mountain Foothill Conifer Savanna	1165	CES306.958
Southern California Oak Woodland and Savanna	1118	CES206.938
Southern Rocky Mountain Juniper Woodland and Savanna	1119	CES306.834
Southern Rocky Mountain Ponderosa Pine Savanna	1117	CES306.826
Willamette Valley Upland Prairie and Savanna	1120	CES204.858
Woody Wetland		
Columbia Basin Foothill Riparian Woodland and Shrubland	1154	CES304.768
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland	1154	CES304.045
North American Warm Desert Riparian Systems	1155	CES302.612
North American Warm Desert Lower Montane Riparian Woodland and Shrubland	1155	CES302.748
North American Warm Desert Riparian Mesquite Bosque	1155	CES302.752

North American Warm Desert Riparian Woodland and Shrubland	1155	CES302.753
North Pacific Lowland Riparian Forest and Shrubland	1156	CES204.869
North Pacific Montane Riparian Woodland and Shrubland	1158	CES204.866
North Pacific Swamp Systems	1157	CES204.613
North Pacific Hardwood-Conifer Swamp	1157	CES204.090
North Pacific Shrub Swamp	1157	CES204.865
Northern Rocky Mountain Conifer Swamp	1161	CES306.803
Rocky Mountain Montane Riparian Systems	1159	CES306.614
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	1159	CES306.804
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	1159	CES306.821
Rocky Mountain Subalpine/Upper Montane Riparian Systems	1160	CES306.832
Rocky Mountain Subalpine/Upper Montane Riparian Systems	1160	CES306.833
Western Great Plains Floodplain Systems	1162	CES303.616
Northwestern Great Plains Floodplain	1162	CES303.676
Western Great Plains Floodplain	1162	CES303.678

* Systems which are italicized and indented are aggregates of the system preceding the italics.

Eastern U.S. Draft Biophysical Settings Legend

Ecological System Name *	BpS Code	NatureServe Code
Barren		
Atlantic Coastal Plain Xeric River Dune	1388	CES203.497
Caribbean Coastal Beach Systems	1496	CES411.644
South Florida Shell Hash Beach	1496	CES411.271
Southeast Florida Beach	1496	CES411.272
Southwest Florida Beach	1496	CES411.276
Central Interior and Appalachian Sparsely Vegetated Systems	1497	CES202.645
Southern Appalachian Granitic Dome	1497	CES202.297
Southern Appalachian Rocky Summit	1497	CES202.327
Great Lakes Alvar	1409	CES201.721
Gulf and Atlantic Coastal Plain Sparsely Vegetated Systems	1498	CES203.646
Atlantic Coastal Plain Central Sandy Beach	1498	CES203.064
Florida Panhandle Beach Vegetation	1498	CES203.266
Northern Atlantic Coastal Plain Sandy Beach	1498	CES203.301
Atlantic Coastal Plain Sea Island Beach	1498	CES203.383
Louisiana Beach	1498	CES203.469
East Gulf Coastal Plain Dry Chalk Bluff	1498	CES203.492
Atlantic Coastal Plain Southern Beach	1498	CES203.535
Upper Texas Coast Beach	1498	CES203.544
Laurentian-Acadian Sparsely Vegetated Systems	1499	CES201.647
Great Lakes Acidic Rocky Shore and Cliff	1499	CES201.025
Great Lakes Dune	1499	CES201.026
North Atlantic Cobble Shore	1499	CES201.051
Laurentian-Acadian Rocky Lakeshore	1499	CES201.586

Northwestern Great Plains Canyon	1341	CES303.658
South Texas Salt and Brackish Tidal Flat	1500	CES301.461
Western Great Plains Sparsely Vegetated Systems	1007	CES303.623
Western Great Plains Badlands	1007	CES303.663
Southwestern Great Plains Canyon	1007	CES303.664
Forest and Woodland		
Acadian Low-Elevation Spruce-Fir-Hardwood Forest	1373	CES201.565
Acadian-Appalachian Montane Spruce-Fir-Hardwood Forest	1374	CES201.566
Allegheny-Cumberland Dry Oak Forest and Woodland	1317	CES202.359
Appalachian (Hemlock)-Northern Hardwood Forest	1370	CES202.593
Appalachian Serpentine Woodland	1375	CES202.347
Appalachian Shale Barrens	1340	CES202.598
Atlantic Coastal Plain Central Maritime Forest	1361	CES203.261
Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest	1335	CES203.241
Atlantic Coastal Plain Fall-line Sandhills Longleaf Pine Woodland	1346	CES203.254
Atlantic Coastal Plain Mesic Hardwood and Mixed Forest	1343	CES203.242
Atlantic Coastal Plain Southern Maritime Forest	1382	CES203.537
Atlantic Coastal Plain Upland Longleaf Pine Woodland	1347	CES203.281
Boreal Aspen-Birch Forest	1301	CES103.020
Boreal Jack Pine-Black Spruce Forest	1344	CES103.022
Boreal White Spruce Forest and Woodland	1345	CES105.848
Boreal White Spruce-Fir-Hardwood Forest	1365	CES103.021
Central and Southern Appalachian Montane Oak Forest	1320	CES202.596
Central and Southern Appalachian Spruce-Fir Forest	1350	CES202.028
Central Appalachian Dry Oak-Pine Forest	1369	CES202.591
Central Appalachian Pine-Oak Rocky Woodland	1377	CES202.600
Central Florida Upland Longleaf Pine Island	1356	CES203.284
Central Interior Highlands Dry Acidic Glade and Barrens	1363	CES202.692
Central Texas Coastal Fringe Forest and Woodland	1338	CES203.464
Crosstimbers Oak Forest and Woodland	1308	CES205.682
Crosstimbers Southern Pine Forest and Woodland	1358	CES205.896
East Gulf Coastal Plain Interior Shortleaf Pine-Oak Forest	1372	CES203.506
East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland	1349	CES203.496
East Gulf Coastal Plain Limestone Forest	1328	CES203.502
East Gulf Coastal Plain Maritime Forest	1380	CES203.503
East Gulf Coastal Plain Northern Dry Upland Hardwood Forest	1307	CES203.483
East Gulf Coastal Plain Northern Loess Bluff Forest	1327	CES203.481
East Gulf Coastal Plain Northern Loess Plain Oak-Hickory Upland	1306	CES203.482
East Gulf Coastal Plain Northern Mesic Hardwood Slope Forest	1325	CES203.477
East Gulf Coastal Plain Southern Loess Bluff Forest	1329	CES203.556
East Gulf Coastal Plain Southern Mesic Slope Forest	1357	CES203.476
Eastern Great Plains Tallgrass Aspen Parkland	1331	CES205.688
Edwards Plateau Limestone Forest, Woodland and Glade	1383	CES303.660
Florida Peninsula Inland Scrub	1387	CES203.057
Laurentian-Acadian Northern Hardwoods Forest	1302	CES201.564
Laurentian-Acadian Northern Pine-(Oak) Forest	1362	CES201.719
Laurentian-Acadian Pine-Hemlock-Hardwood Forest	1366	CES201.563
Llano Uplift Granitic Forest, Woodland and Glade	1410	CES303.657

Lower Mississippi River Dune Woodland and Forest	1381	CES203.531
Madrean Encinal	1023	CES305.795
Madrean Pinyon-Juniper Woodland	1025	CES305.797
Mississippi Delta Maritime Forest	1384	CES203.513
Mississippi River Alluvial Plain Loess Slope Forest	1322	CES203.037
North-Central Appalachian Pine Barrens	1354	CES202.590
North-Central Interior Beech-Maple Forest	1313	CES202.693
North-Central Interior Dry Oak Forest and Woodland	1311	CES202.047
North-Central Interior Dry-Mesic Oak Forest and Woodland	1310	CES202.046
North-Central Interior Maple-Basswood Forest	1314	CES202.696
Northeastern Interior Dry-Mesic Oak Forest	1303	CES202.592
Northern Atlantic Coastal Plain Dry Hardwood Forest	1324	CES203.475
Northern Atlantic Coastal Plain Maritime Forest	1379	CES203.302
Northern Atlantic Coastal Plain Pitch Pine Barrens	1355	CES203.269
Northwestern Great Plains Highland Spruce Woodland	1048	CES303.957
Ouachita Montane Oak Forest	1312	CES202.306
Ozark-Ouachita Dry Oak Woodland	1364	CES202.707
Ozark-Ouachita Dry-Mesic Oak Forest	1304	CES202.708
Ozark-Ouachita Mesic Hardwood Forest	1334	CES202.043
Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland	1367	CES202.313
Rocky Mountain Foothill Limber Pine-Juniper Woodland	1049	CES306.955
South Florida Hardwood Hammock	1333	CES411.287
South Florida Pine Rockland	1360	CES411.367
South-Central Interior / Upper Coastal Plain Flatwoods	1326	CES203.479
South-Central Interior Mesophytic Forest	1321	CES202.887
Southeast Florida Coastal Strand and Maritime Hammock	1337	CES411.369
Southeastern Interior Longleaf Pine Woodland	1351	CES202.319
Southern and Central Appalachian Cove Forest	1318	CES202.373
Southern Appalachian Low Mountain Pine Forest	1353	CES202.332
Southern Appalachian Montane Pine Forest and Woodland	1352	CES202.331
Southern Appalachian Northern Hardwood Forest	1309	CES202.029
Southern Appalachian Oak Forest	1315	CES202.886
Southern Coastal Plain Dry Upland Hardwood Forest	1330	CES203.560
Southern Interior Low Plateau Dry Oak Forest	1305	CES202.898
Southern Piedmont Dry Oak-(Pine) Forest	1368	CES202.339
Southern Piedmont Mafic Hardpan Woodland	1342	CES202.268
Southern Piedmont Mesic Forest	1316	CES202.342
Southern Piedmont Northern Triassic Basin Dry Forest	1319	CES202.552
Southern Ridge and Valley Dry Calcareous Forest	1376	CES202.457
Southern Rocky Mountain Pinyon-Juniper Woodland	1059	CES306.835
Southwest Florida Coastal Strand and Maritime Hammock	1336	CES411.368
West Gulf Coastal Plain Chenier and Upper Texas Coastal Fringe Forest and Woodland	1339	CES203.466
West Gulf Coastal Plain Mesic Hardwood Forest	1323	CES203.280
West Gulf Coastal Plain Pine-Hardwood Forest	1371	CES203.378
West Gulf Coastal Plain Sandhill Oak and Shortleaf Pine Forest and Woodland	1378	CES203.056
West Gulf Coastal Plain Upland Longleaf Pine Forest and Woodland	1348	CES203.293
Western Great Plains Dry Bur Oak Forest and Woodland	1013	CES303.667

Herbaceous		
Atlantic Coastal Plain Southern Dune and Maritime Grassland	1426	CES203.273
Bluegrass Basin Savanna and Woodland	1413	CES202.888
Central Mixedgrass Prairie	1132	CES303.659
Central Tallgrass Prairie	1421	CES205.683
Chihuahuan Sandy Plains Semi-Desert Grassland	1133	CES302.736
Crosstimbers Southern Xeric Sandhill	1424	CES205.897
East Gulf Coastal Plain Black Belt Calcareous Prairie and Woodland	1430	CES203.478
East Gulf Coastal Plain Jackson Plain Prairie and Barrens	1427	CES203.353
East Gulf Coastal Plain Jackson Prairie and Woodland	1433	CES203.555
Eastern Highland Rim Prairie and Barrens	1417	CES202.354
Florida Dry Prairie	1425	CES203.380
Lower Mississippi Alluvial Plain Grand Prairie	1432	CES203.549
North-Central Interior Sand and Gravel Tallgrass Prairie	1412	CES202.695
Northern Tallgrass Prairie	1420	CES205.686
Northwestern Great Plains Mixedgrass Prairie	1141	CES303.674
Pennyroyal Karst Plain Prairie and Barrens	1418	CES202.355
South Texas Lomas	1439	CES301.462
South Texas Sand Sheet Grassland	1442	CES301.538
Southeastern Great Plains Tallgrass Prairie	1423	CES205.685
Southern Appalachian Grass and Shrub Bald	1414	CES202.294
Southern Blackland Tallgrass Prairie	1422	CES205.684
Southern Ridge and Valley Patch Prairie	1419	CES202.453
Southwest Florida Dune and Coastal Grassland	1431	CES203.539
Tamaulipan Clay Grassland	1440	CES301.987
Tamaulipan Savanna Grassland	1438	CES301.985
Tamaulipan Tallgrass Grassland	1441	CES301.988
West Gulf Coastal Plain Northern Calcareous Prairie	1428	CES203.377
West Gulf Coastal Plain Southern Calcareous Prairie	1429	CES203.379
Western Great Plains Foothill and Piedmont Grassland	1147	CES303.817
Western Great Plains Sand Prairie	1148	CES303.670
Western Great Plains Shortgrass Prairie	1149	CES303.672
Western Great Plains Tallgrass Prairie	1150	CES303.673
Western Highland Rim Prairie and Barrens	1416	CES202.352

Herbaceous Wetland		
Central Interior and Appalachian Herbaceous Wetland Systems	1493	CES202.641
North-Central Interior Freshwater Marsh	1493	CES202.899
East Gulf Coastal Plain Treeless Savanna and Wet Prairie	1485	CES203.192
Eastern Great Plains Wet Meadow, Prairie, and Marsh	1488	CES205.687
Floridian Highlands Freshwater Marsh	1489	CES203.077
Great Lakes Coastal Marsh Systems	1492	CES201.640
Northern Great Lakes Coastal Marsh	1492	CES201.722
Great Lakes Freshwater Estuary and Delta	1492	CES202.033
Gulf and Atlantic Coastal Plain Tidal Marsh Systems	1490	CES203.638
Atlantic Coastal Plain Indian River Lagoon Tidal Marsh	1490	CES203.257
Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh	1490	CES203.260

Atlantic Coastal Plain Central Salt and Brackish Tidal Marsh	1490	CES203.270
Mississippi Sound Salt and Brackish Tidal Marsh	1490	CES203.303
Gulf Coast Chenier Plain Fresh and Oligohaline Tidal Marsh	1490	CES203.467
Mississippi Delta Fresh and Oligohaline Tidal Marsh	1490	CES203.470
Mississippi Delta Salt and Brackish Tidal Marsh	1490	CES203.471
Central and Upper Texas Coast Fresh and Oligohaline Tidal Marsh	1490	CES203.472
Central and Upper Texas Coast Salt and Brackish Tidal Marsh	1490	CES203.473
Florida Big Bend Fresh-Oligohaline Tidal Marsh	1490	CES203.507
Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	1490	CES203.516
Northern Atlantic Coastal Plain Tidal Salt Marsh	1490	CES203.519
Northern Atlantic Coastal Plain Brackish Tidal Marsh	1490	CES203.894
Laurentian-Acadian Herbaceous Wetland Systems	1494	CES201.642
Laurentian-Acadian Wet Meadow-Shrub Swamp	1494	CES201.582
Laurentian-Acadian Freshwater Marsh	1494	CES201.594
Laurentian-Acadian Salt Marsh and Estuary Systems	1491	CES201.639
Acadian Coastal Salt Marsh	1491	CES201.578
Acadian Estuary Marsh	1491	CES201.579
South Florida Everglades Sawgrass Marsh	1483	CES411.286
South Florida Wet Marl Prairie	1484	CES411.370
Texas-Louisiana Coastal Prairie Pondshore	1487	CES203.541
Texas-Louisiana Saline Coastal Prairie	1486	CES203.543
Western Great Plains Depressional Wetland Systems	1495	CES303.643
Western Great Plains Closed Depression Wetland	1495	CES303.666
Western Great Plains Saline Depression Wetland	1495	CES303.669
Western Great Plains Open Freshwater Depression	1495	CES303.675

Mixed Upland and Wetland		
Acadian Near-Boreal Spruce Barrens	1464	CES201.561
Acadian Near-Boreal Spruce Flat	1465	CES201.562
Atlantic Coastal Plain Northern Dune and Maritime Grassland	1436	CES203.264
Central and Upper Texas Coast Dune and Coastal Grassland	1437	CES203.465
Central Florida Pine Flatwoods	1453	CES203.382
Central Interior and Appalachian Floodplain Systems	1471	CES202.627
Central Appalachian Floodplain	1471	CES202.608
North-Central Interior Floodplain	1471	CES202.694
South-Central Interior Large Floodplain	1471	CES202.705
Central Interior and Appalachian Riparian Systems	1472	CES202.628
Central Appalachian Small Stream Riparian	1472	CES202.609
Ozark-Ouachita Riparian	1472	CES202.703
South-Central Interior Small Stream and Riparian	1472	CES202.706
East Gulf Coastal Plain Dune and Coastal Grassland	1435	CES203.500
East Gulf Coastal Plain Near-Coast Pine Flatwoods	1454	CES203.375
Eastern Boreal Floodplain	1444	CES103.588
Eastern Great Plains Floodplain Systems	1469	CES205.625
North-Central Interior Floodplain	1469	CES202.694
Great Lakes Dune and Swale	1466	CES201.726
Great Lakes Wet-Mesic Lakeplain Prairie	1411	CES202.027
Great Plains Prairie Pothole	1482	CES303.661
Gulf and Atlantic Coastal Plain Sparsely Vegetated Systems	1498	CES203.646

Texas Coastal Bend Beach	1498	CES203.463
Laurentian-Acadian Floodplain Systems	1475	CES201.631
Laurentian-Acadian Floodplain Forest	1475	CES201.587
Laurentian-Acadian Ice-Scour Rivershore	1475	CES201.589
North American Warm Desert Riparian Systems	1155	CES302.612
Chihuahuan-Sonoran Desert Bottomland and Swale Grassland	1155	CES302.746
Northwestern Great Plains Aspen Forest and Parkland	1009	CES303.681
South Florida Pine Flatwoods	1446	CES411.381
South Texas Dune and Coastal Grassland	1443	CES301.460
Texas-Louisiana Coastal Prairie	1434	CES203.550
West Gulf Coastal Plain Pine-Hardwood Flatwoods	1458	CES203.278
Western Great Plains Floodplain Systems	1162	CES303.616
Northwestern Great Plains Riparian	1162	CES303.677
Western Great Plains Wooded Draw and Ravine	1385	CES303.680
Shrubland		
Acadian-Appalachian Alpine Barrens	1386	CES201.567
Acadian-Appalachian Subalpine Woodland and Barrens	1389	CES201.568
Apacherian-Chihuahuan Mesquite Upland Scrub	1095	CES302.733
Chihuahuan Mixed Salt Desert Scrub	1075	CES302.017
Colorado Plateau Mixed Low Sagebrush Shrubland	1064	CES304.762
Edwards Plateau Limestone Shrubland	1393	CES303.041
Inter-Mountain Basins Big Sagebrush Shrubland	1080	CES304.777
Inter-Mountain Basins Mixed Salt Desert Scrub	1081	CES304.784
Laurentian-Acadian Sparsely Vegetated Systems	1499	CES201.647
Acadian-North Atlantic Rocky Coast	1499	CES201.573
North Pacific Mesic Low Shrubland	1069	CES204.855
Northwestern Great Plains Shrubland	1085	CES303.662
Rocky Mountain Lower Montane-Foothill Shrubland	1086	CES306.822
Tamaulipan Calcareous Thornscrub	1392	CES301.986
Tamaulipan Mesquite Upland Scrub	1391	CES301.984
Tamaulipan Mixed Deciduous Thornscrub	1390	CES301.983
Western Great Plains Mesquite Woodland and Shrubland	1111	CES303.668
Western Great Plains Sandhill Shrubland	1094	CES303.671
Steppe/Savanna		
Alabama Ketona Glade and Woodland	1408	CES202.338
Apacherian-Chihuahuan Semi-Desert Grassland and Steppe	1121	CES302.735
Central Appalachian Alkaline Glade and Woodland	1400	CES202.602
Central Interior Highlands Calcareous Glade and Barrens	1401	CES202.691
Cumberland Sandstone Glade and Barrens	1398	CES202.337
Laurentian Pine-Oak Barrens	1407	CES201.718
Madrean Juniper Savanna	1116	CES301.730
Nashville Basin Limestone Glade	1397	CES202.334
North-Central Interior Oak Savanna	1394	CES202.698
North-Central Oak Barrens	1395	CES202.727
Panhandle Florida Limestone Glade	1406	CES203.534
Southern and Central Appalachian Mafic Glade and Barrens	1399	CES202.348

Southern Piedmont Glade and Barrens	1396	CES202.328
Southern Rocky Mountain Juniper Woodland and Savanna	1119	CES306.834
Southern Rocky Mountain Ponderosa Pine Savanna	1117	CES306.826
West Gulf Coastal Plain Catahoula Barrens	1403	CES203.364
West Gulf Coastal Plain Nepheline Syenite Glade	1405	CES203.371
West Gulf Coastal Plain Saline Glade	1402	CES203.291
West Gulf Coastal Plain Weches Glade	1404	CES203.277

Woody Wetland		
Atlantic Coastal Plain Clay-Based Carolina Bay Wetland	1459	CES203.245
Atlantic Coastal Plain Northern Pitch Pine Lowland	1456	CES203.374
Atlantic Coastal Plain Northern Wet Longleaf Pine Savanna and Flatwoods	1449	CES203.265
Atlantic Coastal Plain Peatland Pocosin	1452	CES203.267
Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods	1450	CES203.536
Atlantic Coastal Plain Streamhead Seepage Swamp, Pocosin, and Baygall	1468	CES203.252
Boreal Swamp and Bog Systems	1477	CES103.633
Boreal-Laurentian Bog	1477	CES103.581
Boreal-Laurentian Conifer Acid Swamp	1477	CES103.724
Caribbean Coastal Wetland Systems	1470	CES411.626
South Florida Mangrove Swamp	1470	CES411.289
Caribbean Swamp Systems	1478	CES411.634
South Florida Hydric Hammock	1478	CES411.273
South Florida Bayhead Swamp	1478	CES411.366
Central Interior and Appalachian Floodplain Systems	1471	CES202.627
Southern Piedmont Large Floodplain Forest	1471	CES202.324
Central Interior and Appalachian Herbaceous Wetland Systems	1493	CES202.641
North-Central Interior Wet Meadow-Shrub Swamp	1493	CES202.701
Central Interior and Appalachian Riparian Systems	1472	CES202.628
Cumberland Riverscour	1472	CES202.036
Southern Piedmont Small Floodplain and Riparian Forest	1472	CES202.323
Central Interior and Appalachian Swamp Systems	1479	CES202.635
North-Central Appalachian Acidic Swamp	1479	CES202.604
North-Central Interior and Appalachian Rich Swamp	1479	CES202.605
North-Central Interior and Appalachian Acid Peatland	1479	CES202.606
North-Central Interior Wet Flatwoods	1479	CES202.700
East Gulf Coastal Plain Southern Loblolly-Hardwood Flatwoods	1455	CES203.557
East Gulf Coastal Plain Tidal Wooded Swamp	1463	CES203.299
Gulf and Atlantic Coastal Plain Floodplain Systems	1473	CES203.629
Red River Large Floodplain Forest	1473	CES203.065
Atlantic Coastal Plain Large River Floodplain Forest	1473	CES203.066
Mississippi River Riparian Forest	1473	CES203.190
Mississippi River Low Floodplain (Bottomland) Forest	1473	CES203.195
Mississippi River High Floodplain (Bottomland) Forest	1473	CES203.196
Atlantic Coastal Plain Small Blackwater River Floodplain Forest	1473	CES203.249
Atlantic Coastal Plain Small Brownwater River Floodplain Forest	1473	CES203.250
West Gulf Coastal Plain Near Coast Large River Swamp	1473	CES203.459
West Gulf Coastal Plain Large River Floodplain Forest	1473	CES203.488
East Gulf Coastal Plain Large River Floodplain Forest	1473	CES203.489
Southern Coastal Plain Blackwater River Floodplain Forest	1473	CES203.493

Gulf and Atlantic Coastal Plain Small Stream Riparian Systems	1474	CES203.630
Atlantic Coastal Plain Blackwater Stream Floodplain Forest	1474	CES203.247
Atlantic Coastal Plain Brownwater Stream Floodplain Forest	1474	CES203.248
West Gulf Coastal Plain Small Stream and River Forest	1474	CES203.487
West Gulf Coastal Plain Texas-Louisiana Coastal Prairie Slough	1474	CES203.542
East Gulf Coastal Plain Small Stream and River Floodplain Forest	1474	CES203.559
Gulf and Atlantic Coastal Plain Swamp Systems	1480	CES203.636
Atlantic Coastal Plain Southern Tidal Wooded Swamp	1480	CES203.240
Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest	1480	CES203.304
Southern Coastal Plain Nonriverine Basin Swamp	1480	CES203.384
Lower Mississippi River Bottomland Depression	1480	CES203.490
Southern Coastal Plain Hydric Hammock	1480	CES203.501
Northern Atlantic Coastal Plain Basin Swamp and Wet Hardwood Forest	1480	CES203.520
Northern Atlantic Coastal Plain Peat Swamp	1480	CES203.522
West Gulf Coastal Plain Nonriverine Wet Hardwood Flatwoods	1480	CES203.548
East Gulf Coastal Plain Northern Seepage Swamp	1480	CES203.554
Laurentian-Acadian Herbaceous Wetland Systems	1494	CES201.642
Boreal-Laurentian-Acadian Acidic Basin Fen	1494	CES201.583
Laurentian-Acadian Swamp and Bog Systems	1481	CES201.637
Laurentian-Acadian Conifer-Hardwood Acid Swamp	1481	CES201.574
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	1481	CES201.575
Acadian-Appalachian Conifer Seepage Forest	1481	CES201.576
Acadian Maritime Bog	1481	CES201.580
North American Warm Desert Riparian Systems	1155	CES302.612
North American Warm Desert Riparian Woodland and Shrubland	1155	CES302.753
South Florida Cypress Dome	1447	CES411.365
South Florida Dwarf Cypress Savanna	1445	CES411.290
South Florida Willow Head	1448	CES411.484
South-Central Interior / Upper Coastal Plain Wet Flatwoods	1457	CES203.480
Southern Coastal Plain Nonriverine Cypress Dome	1460	CES203.251
Southern Coastal Plain Seepage Swamp and Baygall	1461	CES203.505
Tamaulipan Floodplain	1467	CES301.990
Tamaulipan Riparian Systems	1476	CES301.632
Tamaulipan Palm Grove Riparian Forest	1476	CES301.991
Tamaulipan Arroyo Shrubland	1476	CES301.992
West Gulf Coastal Plain Seepage Swamp and Baygall	1462	CES203.372
West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods	1451	CES203.191
Western Great Plains Floodplain Systems	1162	CES303.616
Northwestern Great Plains Floodplain	1162	CES303.676
Western Great Plains Floodplain	1162	CES303.678

* Systems which are italicized and indented are aggregates of the system preceding the italics.

Appendix E: LANDFIRE Vegetation Modeling
Cover/Height Breaks by Class

Instructions: LANDFIRE Vegetation classes (A-E) must be mutually exclusive by height, cover, and/or lifeform. Use this worksheet to track the height and cover ranges in each class by entering each class letter under its height/cover combination. Note that:

(a) any overlap will not be mappable and must be rectified unless clear lifeform differences exist.

(b) any gaps (no classes) in height/cover will be mapped as uncharacteristic and will increase departure (FRCC).

			COVER								
HEIGHT			11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%
Herb	short	0-0.5m									
Herb	medium	0.5-1m									
Herb	tall	>1m									
Shrub	dwarf	0-0.5m									
Shrub	short	0.5-1.0m									
Shrub	medium	1-3m									
Shrub	tall	>3m									
Tree	regen	0-5m									
Tree	short	5-10m									
Tree	medium	10-25m									
Tree	tall	25-50m									
Tree	giant	>50m									

Appendix F: Key to Model Tracker Database Fields

General Information Section	
Field Name	**Instructions**
Biophysical Setting Code	7 digit BPS ID: ***##BPSI0*** where: • ***##*** = the mapzone number, and • ***BPSI*** = the unique BpS I.D. that was assigned to each BpS. • ***0*** = If a BpS is split, the multiple models will be numbered sequentially beginning with 1. Otherwise, the BpS is assigned a 0 for the seventh digit.
Biophysical Setting Name	The Ecological System name ("Cover Type or Ecological System Name"), as defined by NatureServe.
Land Cover Class	The land cover class, as defined for the BpS: • Forest and Woodland • Upland Shrubland • Upland Savanna and Shrub-Steppe • Upland Grassland and Herbaceous • Wetlands and Riparian
Dominant Species	The NRCS Plants Code of at least one and up to eight dominant species for the BPS. These should reflect the *majority* of the landscape in the BPS and should be in order of dominance. If you don't know the NRCS Plants Code, you can search the NRCS Plants Database this way: 1. Click in a Dominant Species field. 2. Click on the Dominant Species button. A new window called NRCS Species Codes will open. 3. Put your cursor (click your mouse) in the box next to the name by which you'd like to search for the species, either Scientific Name or Common Name. 4. Click on the binoculars symbol. A new (called Find and Replace) window will open. 5. Type the name (scientific or common, depending on which you clicked earlier) of the plant in the Find What: box and select Find Next. The database will search for your species—it may take a while; there are over 82,000 plants! The code will be returned in the original NRCS Species Codes window. 6. When your species is found, select Exit with Code. The database will automatically input the code into the field where your cursor was. To search for another species, repeat the process.
Geographic Range	The geographic distribution of this BPS. Reference states, ecoregions, physiographic provinces, etc.
Biophysical Site Description	The characteristic biophysical gradients for this BPS. This may include things like elevation, slope, aspect, soils, precipitation, and temperature.
Disturbance Description	The dominant disturbances that impact this BPS, including the agents, frequency, severity, and seasonality. Where applicable, describe the differential distribution of fire severity classes (e.g., "replacement fire typically occurs in classes B and E").
Vegetation Description	The vegetation of this BPS, including species, structure, and botanical characteristics.

General Information Section	
Field Name	**Instructions**
Adjacency/ Identification Concerns	Information that may help identify the BPS in the field, including: • synonomous local classifications (e.g., habitat type, plant association), • adjacent BPSs, • BPSs that this one may be confused with, • typical identifiers not described elsewhere, and • uncharacteristic types (i.e., patterns or processes that wouldn't have existed under the historic range of variability, like exotics) that may frequently occur in this BPS today.
Scale Description	The typical scale of the most common disturbance extent, the general minimum analysis area (e.g., the minimum size that would encompass the mosaic of this BPS), and/or the average patch size. Cite any sources you used. Be clear about what scale you are describing.
Scale Source	The sources of information about scale. • Literature: that the values entered came from published sources. • Local data: the values entered came from local observations or records. • Expert estimate: the values entered were estimated by experts.
Issues/ Problems	Any difficulties, issues, or concerns about the model, the availability of data on this BPS, or other considerations.
Comments & Suggested Reviewers	Lists suggested reviewers and document information from peer-reviews or workshop feedback. This is also where peer-review is be tracked.
Un-Characteristic Native Vegetation Conditions	Describes any vegetation conditions that include only native species, but would be considered uncharacteristic, such as canopy cover ranges, native species, or height classes that would not have occurred in this BPS under the natural range of variability.
Modelers 1-3 and Email	Modeler names and email addresses, in order of authorship. If there are additional authors, they are listed in the *Comments* field.
Date	The date the model was finalized.
Model Source	The sources of information consulted for the model in general. • Literature: the model generally came from published sources. • Local data: the model generally came from local research or information. • Expert estimate: the model was generally estimated by experts.
BPS Lumped With	Checked if this BpS has been lumped with any others (i.e., their models are identical). In the adjacent text field, the other BpS ID number(s) are listed. Similarities/differences may be elaborated upon here and in the *Adjacency/Identification Concerns* field.
BpS Split into multiple Models	Checked if this BpS has been split into multiple models. In the adjacent text field, modelers describe how the split is defined so that it may be mapped.
Model Zone	Model Zone(s) to which the model applies. See the map below for the geography of your Model Zone.
Map Zone	The LANDFIRE map zone(s) to which the model applies. Mapping zones are listed only when the model has been approved for that zone.

General Information Section	
Field Name	**Instructions**
Feedback for NatureServe	Comments about how this Ecological System has been defined or described for NatureServe.

Vegetation Classes (A-E) Section	
Field Name	**Instructions**
Class %	Percent of the landscape, as output from the VDDT model rounded to the nearest 5%.
Cover Type	Cover types for class A-E (e.g., Early, Mid, Late).
Structure Class	Structure classes for class A-E (e.g., All, Open, Closed).
Description	Describes the structure, composition, and other attributes for each class.
Indicator Species	The NRCS Plants Code of up to four indicator species for the vegetation class. Indicator species may or may not be the dominant species.
Indicator Species Canopy Position	The relative position of each indicator species in the canopy. Options for canopy position are: • *Upper*: upper-most portion of the canopy; dominant or emergent. • *Mid-Upper*: ranging from middle to upper portions of the canopy; co-dominant. • *Middle*: middle section of the canopy; co-dominant or intermediate. • *Lower-Mid*: lower to the middle portions of the canopy; intermediate or suppressed. • *Lower*: below the main canopy; may be suppressed or understory. • *All*: can vary between any canopy position, or occupies all levels of the canopy.

Vegetation Classes (A-E) Section	
Field Name	**Instructions**

Fuel Model — The standard fire behavior fuel model[18] for the class, if known. Fuel models are:

#	*Vegetation Type*	*Fuels*
1	Perennial grasslands, annual grasslands, savannahs, grass-tundra, grass-shrub with < 1/3 shrub or timber	Cured fine, porous herbaceous; .5-.9 tons surface fuel load per acre; .5-2 foot depth
2	Shrub, pine, oak, pinyon-juniper with < 2/3 shrub or timber cover	Fine herbaceous surface cured or dead, litter, dead stem or limb wood; 1-4 tons surface fuel load per acre; .5-2 foot depth
3	Tall grassland, prairie, and Meadow	Tall herbaceous surface with > 1/3 dead or cured; 2-4 tons fuel load per acre; 2-3 foot depth
4	Coastal/Sierra chaparral, pocosin shrub (fetterbrush, gallberry, bays), southern rough shrub, closed jack pine, pine barrens	Flammable foliage and small dead woody material with or w/o litter layer; 10-15 tons fuel load per acre; 4-8 foot depth
5	Moist or cool shrub types (laurel, vine maple, alder, manzanita, chamise), forest/shrub, regeneration shrubfields after fire or harvest	Green foliage with or w/o litter; 3-5 tons per acre; 1-3 foot depth
6	Pinyon-juniper w/ shrubs, southern hardwood/ shrub w/ pine, frost killed gambel oak, pocosin shrub, chamise, chaparral, spruce-taiga, shrub-tundra, hardwood slash	Flammable foliage, but shorter and more open than FM 4 w/ less dead small wood and litter; 4-8 tons per acre; 2-4 foot depth
7	Palmetto-gallberry w/ or w/o pine overstory, black spruce/shrub, southern rough, slash pine/gallberry	Flammable foliage even when green; 4-6 tons per acre; 2-3 foot depth
8	Closed canopy short needle conifer types, closed canopy broadleaf or hardwood types	Usually low to moderately flammable foliage with litter or scattered vegetation understory; 4-6 tons per acre surface fuels; .1-.5 foot depth
9	Long needle (ponderosa, Jeffrey, red, southern) conifer types, oak-hickory and similar hardwood types	Flammable foliage with needle or leaf litter and some dead down woody material; 3-4 tons per acre; .1-.5 feet
10	Any Forest type with > 3” down dead woody fuels)	Dead down > 3” woody fuels and litter; 10-14 tons per acre of total surface fuel < 3”; .5-2 foot depth
11	Light logging slash, partial cut slash	10-14 tons per acre total fuel load < 3”; .5-2 foot depth
12	Moderate and continuous logging slash in clearcuts or heavy partial cuts and thinned areas	30-40 tons per acre total fuel load < 3”; 2-3 foot depth
13	Heavy and continuous logging slash in clearcuts or heavy partial cuts and thinned areas	50-60 tons per acre total fuel load > 3”; 2-4 foot depth

[18] Anderson, Hal. 1982. Aids to determining fuel models for estimating fire behavior. USDA Forest Service. Intermountain Forest and Range Experiment Station, Ogden, UT. General Technical Report INT-122. 28 pp.

<table>
<tr><th colspan="2">Vegetation Classes (A-E) Section</th></tr>
<tr><th>Field Name</th><th>Instructions</th></tr>
<tr><td>Upper Layer Lifeform</td><td>Tree, shrub, or herbaceous selected for the lifeform that occupies the upper layer of the canopy.</td></tr>
<tr><td>Minimum and Maximum Canopy Closure</td><td>The minimum and maximum canopy closure expected for the upper layer lifeform of each class.
11-20% 61-70%
21-30% 71-80%
31-40% 81-90%
41-50% 91-100%
51-60%</td></tr>
<tr><td>Minimum and Maximum Height</td><td>The minimum and maximum height for the upper layer lifeform.
<table>
<tr><th colspan="2">Trees</th><th colspan="2">Shrubs</th><th colspan="2">Herbaceous</th></tr>
<tr><td>Regen-eration</td><td><5 m
(~<16 ft)</td><td>Dwarf</td><td><0.5m
(~<1.6 ft)</td><td>Short</td><td><0.5m
(~<1.6 ft)</td></tr>
<tr><td>Short</td><td>5-9 m
(~16-30 ft)</td><td>Short</td><td>05.-0.9m
(~1.6-3 ft)</td><td>Medium</td><td>0.5-0.9m
(~1.6-3 ft)</td></tr>
<tr><td>Medium</td><td>10-24 m
(~30-78 ft)</td><td>Medium</td><td>1-2.9m
(~3-9.5 ft)</td><td>Tall</td><td>>1m
(~3-9.5 ft)</td></tr>
<tr><td>Tall</td><td>24-49 m
(~78-160 ft)</td><td>Tall</td><td>>3m
(~>9.5 ft)</td><td></td><td></td></tr>
<tr><td>Giant</td><td>>50 m
(~>160 ft)</td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Tree Size Class</td><td>If the upper layer lifeform is tree, the maximum tree size class.
<table>
<tr><td>Seedling</td><td><4.5 ft tall
(~<1.4 m)</td></tr>
<tr><td>Sapling</td><td>>4.5 ft tall; <5” DBH
(~>1.4m tall; ~<13 cm DBH)</td></tr>
<tr><td>Pole</td><td>5-9” DBH
(~13-23 cm DBH)</td></tr>
<tr><td>Medium</td><td>9-21” DBH
(~23-53 cm DBH)</td></tr>
<tr><td>Large</td><td>21-33” DBH
(~53-84 cm DBH)</td></tr>
<tr><td>Very Large</td><td>>33” DBH
(~>84 cm DBH)</td></tr>
</table></td></tr>
<tr><td>Upper layer is different from dominant lifeform</td><td>If the upper layer lifeform is different from the dominant lifeform (e.g., in a savanna type system), the canopy cover range and height for the dominant lifeform are described.</td></tr>
<tr><td>Total</td><td>This value is automatically calculated.</td></tr>
</table>

Disturbances Section	
Field Name	**Instructions**
Fire Regime Group	The single *dominant* Fire Regime Group. • FRG I = 0-35 year frequency; low and mixed severity • FRG II = 0-35 year frequency; replacement severity • FRG III = 35-200 year frequency; low and mixed severity • FRG IV = 35-200 year frequency; replacement severity • FRG V = 200+ year frequency
Fire Regime Sources	The sources for information about fire intervals: • <u>Literature</u>: the values entered came from published sources. • <u>Local data</u>: the values entered came from local observations or records. • <u>Expert estimate</u>: the values entered were estimated by experts.
Average Fire Interval (Frequency)	*This field should match values in VDDT model.* For each severity class (Replacement, Mixed Severity, Surface), the average (or other central tendency) fire interval in years, as used in the VDDT model. Fire interval is defined as the number of years between fires.
Minimum Fire Interval (Frequency)	For each severity class (Replacement, Mixed Severity, Surface), the minimum fire interval (smallest number) in years. This is not the statistical minimum and is for informational purposes. It is not derived from the VDDT model.
Maximum Fire Interval (Frequency)	For each severity class (Replacement, Mixed Severity, Surface), the maximum fire interval (largest number) in years. This is not the statistical maximum and is for informational purposes. It is not derived from the VDDT model.
Probability	*This value is automatically calculated.* Probability is equal to 1/Average Frequency. It should closely mirror the probability of fire in the model.
Percent all fires	*This value is automatically calculated.* Percent all fires is equal to probability of severity class/ All Fire Probability.
All Fire Frequency	*This value is automatically calculated.* All Fire Frequency is equal to 1/ All Fire Probability. It should reflect the AllFire frequency in the model.
All Fire Probability	*This value is automatically calculated.* All Fire Probability will be automatically calculated by the database and is equal to the sum of probabilities for the three severity classes.
Historical Fire Size	The estimated average, minimum, and maximum historical (natural) fire size in acres.
Non-Fire Disturbances	All of the other disturbances used in the model.

References	
Field Name	**Explanation**
References	Lists all of the references used while creating this model, whether or not they are cited directly in the text.

For LANDFIRE Staff Use Only Section	
Field Name	**Instructions**
Reviewers	People who provided formal review of this BpS will be listed here.
FRCC	A member of the FRCC team who reviews this BpS will be listed here.
Quality Control and Peer Review	Names of leads who provide quality control and incorporate peer review will be listed here, along with dates of when those activities were completed.

Appendix G: Modeling Cheatsheet

Starting a Model

1. Point to the database.
   - In VDDT, go to <u>File—Database</u>.
   - Navigate to the database. Select it and click the <u>Open</u> button.

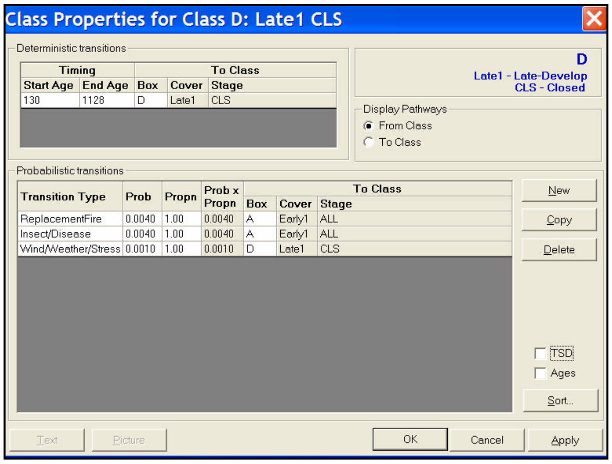
2. Open a model.
   - Go to File—Open.
   - Select the model and click the <u>Open</u> button.

3. Save your model.
   - Saving a model to the current database
     - Use <u>File—Save</u> to save the model with the current name or <u>File—Save As</u> to rename the model.
   - Saving a model to a new database
     - Go to <u>File—Export—Project to MDB</u>. Browse to the database and click the <u>Open</u> button.
     - In the *Export Project As* dialogue box, name and describe your model. Click the <u>Export</u> button.
     - To open your model in the database you just saved to, you must, (a) Go to <u>File—Database</u>. Browse to the database and click the <u>Open</u> button; (b) Go to <u>File—Open</u> and select your model.

Changing the 5 Boxes

1. There can be no more than 5 boxes.
2. To delete a box, go to <u>Diagram—Delete Class</u>.
3. To add a box, go to <u>Diagram—New Class</u>.
4. To change a name of a box, go to <u>Diagram—Edit—Cover and Stage</u>.

Inputs



1. Double-click any box to enter inputs. The dialogue box at the right will appear. The name of the class is shown in the upper right corner.
2. **Deterministic Transitions** (succession)
   - **Timing**: Enter the <u>Start Age</u> and <u>End Age</u> of the class.
   - **To Class**: Enter the letter of the next class on the main successional pathway. There can only be one main succession pathway. You can enter additional "alternative succession" pathways as probabilistic transitions (see below).
3. **Probabilistic Transitions** (disturbance)
   - Click the <u>New</u> button to add a probabilistic transition.
   - **Transition Type**: Use the drop down menu to specify the type of transition. To delete a transition, select the transition and click the <u>Delete</u> button.
   - **Prob**: Enter the probability of that disturbance pathway occuring. Probability is the inverse of frequency (i.e. 1/frequency in years).
   - **To Class**: Enter the class a disturbance will cause a transition toward. Disturbances (except AltSuccession) cannot accellerate a pixel's age.
   - **RelAge**: Leave as 0 unless (1) you are in class A, and (2) the disturbance maintains you in class A, and (3) the disturbance resets the age of the pixels to 0.
   - **Keep Age**: Always leave the <u>Keep Age</u> column set to <u>False</u>.

Running a Model

1. Go to Run—Settings.
   - *General*: Set the Number of timesteps and Number of cells to 1000. Set the Number of simulations to 10.
   - *Initial Conditions*: Set the Total area represented to 1000. Click the Normalize button. Click on the Randomize initial TSD to a maximum of box (if applicable) and enter the value of the maximum TSD used in your model.
   - *Options*: Select Use Time Since Disturbance (if applicable). Click on the Select button to the right of Use Time Since Disturbance and select AllFire as the Associated TSD Group for each transition type that uses TSD.

2. Click Run.

TSD (Time Since Disturbance)

1. If the BPS is fire-maintained, set the main successional pathway along an open path (e.g. A-C-D).
2. Double-click one of the open classes (e.g. C or D). Click on the TSD button.
3. Click on the New button.
4. In the Transition Type column, select AltSuccession from the drop-down menu.
5. In the To Class column, enter the alternative successional pathway from the open type to the closed type (e.g. To Class: B).
6. In the Prob column, enter a probability of 1.
7. In the TSD column, enter the number of years that would have to occur without fire in order to transition to the closed class.
8. When you run the model, select Use Time Since Disturbance on the Run—Settings—*Options* tab and select AllFire as the Associated TSD Group for AltSuccession.

Outputs

To view the **percent of the landscape in each class**:
1. Go to Results—End Values. The table shows the percent in each class at the end of your run. *OR*
2. Go to Results—Bar—Class. The bar graph shows the percent of the landscape (y-axis) in each class (x-axis). *OR*
3. Go to Results—Time—Class. Enter up to four classes to view. The line graphs show the percent of the landscape (y-axis) in each class (individual graphs) over time (x-axis).

To view the **probability of fire and other disturbances**:
1. Go to Results—Time—Transitions. Select up to four transitions (i.e. disturbances) to view.
2. The line graphs show the percent of the landscape (y-axis) that was affected by each disturbance (individual graphs) over time (x-axis).
3. To convert the percent of the landscape affected by the disturbance (y-axis) to a probability, divide the y-axis value by 100.

Recommended Graph Options

To change graph options, go to Results—Graph Options.

- Same y-axis will show all time graphs with the same scale.

- Show Average, Min, Max will display the average, minimum, and maximum of all runs on time graphs.

- Show Mean Line—For Avg Only will:
  - Display the average of all runs at the intervals you request. Enter intervals like 100, 500 to show the average of your model during and after a 100-year calibration period.
  - Display a table with each time graph that shows the average for each requested interval.

Appendix H: Modeling Worksheet

Model Input Worksheet

	Notes	To A	To B	To C	To D	To E
From A						
From B						
From C						
From D						
From E						

Model Output Worksheet

	Notes	*Run 1*	*Run 2*	*Run 3*	*Run 4*	*Run 5*	*Run 6*	*Run 7*	*Run 8*	*Run 9*	*Run 10*
A%											
B%											
C%											
D%											
E%											
AllFire											
Repl											
Mixed											
Surf											

Summary of Modifications

Run 1.

Run 2.

Run 3.

Run 4.

Run 5.

Run 6.

Run 7.

Run 8.

Run 9.

Run 10.