Reviewing & Modifying LANDFIRE
Vegetation Dynamics Models

Cover Photos: Kori Blankenship, Greg Seamon, PlanetWare and Harvey Payne

Acknowledgements

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Introduction

Purpose

The purpose of this document is to provide an introduction to concepts, processes and tools that will allow users to review LANDFIRE vegetation models and descriptions and then alter them as needed for local application. Familiarity with state-and-transition modeling concepts and the Vegetation Dynamics Development Tool software program are helpful but not required to understand the information presented here.

Background

The LANDFIRE project created VEGETATION DYNAMICS MODELS and accompanying descriptions for over 2000 ecosystems (called BIOPHYSICAL SETTINGS; BpS) in the United States. The quantitative state-and-transition models developed using the Vegetation Dynamics Development Tool (VDDT; ESSA Technologies Ltd.) include rates and pathways for succession and disturbance under pre-settlement conditions (Figure 1). The accompanying description document describes the vegetation, geography, biophysical characteristics, succession stages and disturbance regimes of each BpS (Figure 2).
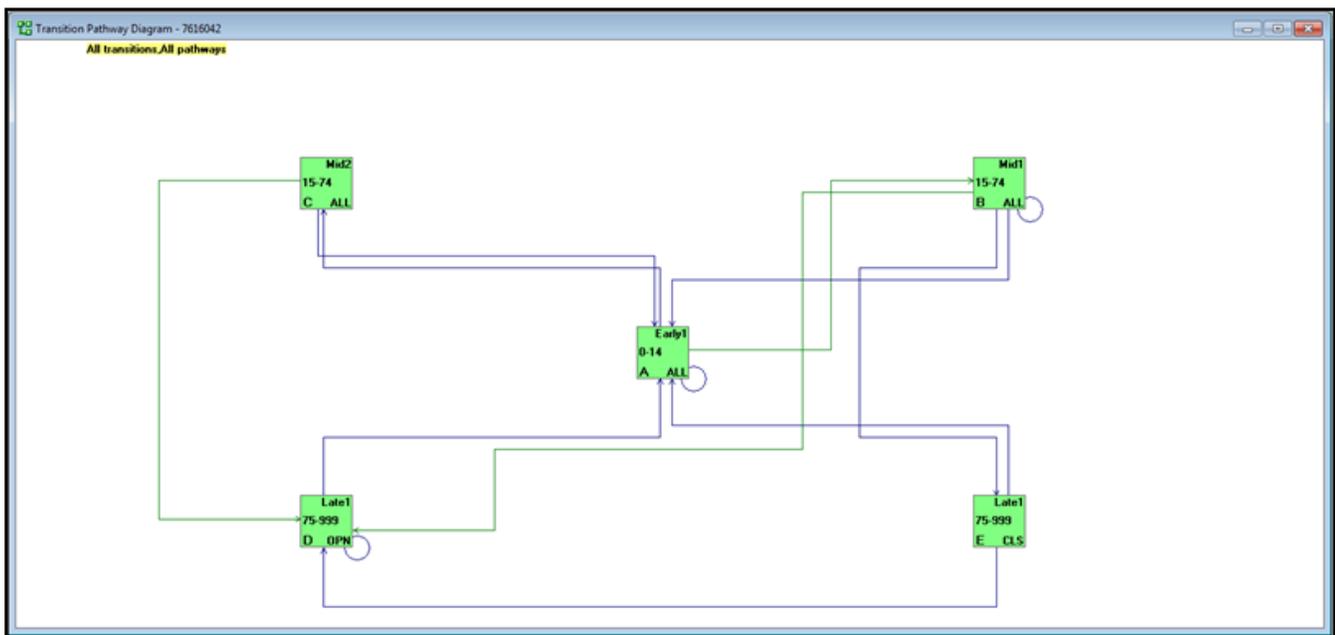

Figure 1. An example of a LANDFIRE state-and-transition model created in VDDT. Each box represents a vegetation state or class defined by its vegetation cover, structure and composition. Green arrows represent succession; blue arrows represent disturbance.

LANDFIRE Biophysical Setting Model

Biophysical Setting 7616042   **Western North American Boreal Mesic Black Spruce Forest - Alaska Sub-boreal**

☑ *This BPS is lumped with: WNA Boreal Spruce-Lichen Woodland (in part)*
☐ *This BPS is split into multiple models: Western North American Boreal Mesic Black Spruce Forest was split into a Boreal and Sub-boreal variant for BpS modeling so that regional differences could be represented.*

Boreal Spruce Lichen Woodland may occur as a seral stage or variant of Boreal Treeline White Spruce Woodland, Boreal Mesic Black Spruce Forest, or, less commonly, in these same systems in the sub-Boreal region.

General Information

Contributors (also see the Comments field)   Date   4/7/2008

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Modeler 3   Reviewer

Vegetation Type	Map Zone	Model Zone	
Forest and Woodland	76	☑ Alaska	☐ N-Cent.Rockies

Dominant Species*		General Model Sources		
PIMA	VAUL	☑ Literature	☐ California	☐ Pacific Northwest
PIGL	VAVI	☐ Local Data	☐ Great Basin	☐ South Central
BENA	EMNI	☑ Expert Estimate	☐ Great Lakes	☐ Southeast
LEDUM	HYSP70		☐ Northeast	☐ S. Appalachians
			☐ Northern Plains	☐ Southwest

Geographic Range
This system occurs in the boreal transition region of AK, south of the Alaska Range, including the Susitna and Matanuska Valleys and the Kenai Peninsula (NatureServe 2008).

Biophysical Site Description
This information was taken from the draft Boreal Ecological Systems description (NatureServe 2008): Sub-boreal Mesic Black Spruce Forest occurs on well-drained to moderately well-drained sites including old alluvial fans, abandoned floodplains and inactive terraces. Soils are gravelly and feature shallow to moderately deep organic horizons. Permafrost is absent.

Vegetation Description
This information was taken from the draft Boreal Ecological Systems description (NatureServe 2008): Picea mariana and P. glauca are the dominant overstory species in an open forest canopy. Common understory shrubs include Betula nana, Ledum spp., V. uliginosum, Vaccinium vitis-idaea and Empetrum nigrum. Common mosses include Hylocomium splendens and Pleurozium schreberi. Total tree cover typically ranges from 40-70%.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

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Figure 2. An example of a LANDFIRE state-and-transition model description document. This type of document accompanies each VDDT model, and provides a description of the BpS, definitions for each state in the state-and-transition model and much more.

LANDFIRE Models Support Efficient and Effective Land Management Planning

The Nature Conservancy of Nevada relied heavily on LANDFIRE models to complete the Bodie Hills Conservation Action Plan for the Bureau of Land Management's Bishop Field Office. The purpose of the plan was to inform and guide the formulation of future site-specific vegetation management projects to protect and enhance the ecological integrity of the area. LANDFIRE models were reviewed and modified by the planning team and other stakeholders to reflect current conditions, management activities and costs. Potential management scenarios were evaluated using computer simulations to test their effectiveness and return on investment. The project has demonstrated the value of collaborative learning, stakeholder input, and cost-benefit analysis using refinements to LANDFIRE products and new remote sensing.

The model shown below represents stable aspen and was created by refining the LANDFIRE BpS model for Rocky Mountain Aspen Forest and Woodland (BpS number 1210110) for the Bodie Hills plan. By adding management activities and associated costs to the model, the planning team was able to develop a set of cost-effective strategies for improving the ecological condition of stable aspen while achieving wildfire protection objectives in the project area.

Early Development Closed → Mid Development Closed → Late Development Closed → Late Development Open

A simplified visual representation of the stable aspen state-and-transition model used to develop management strategies for the Bodie Hills.

Depleted Aspen

Management strategies and costs for stable aspen under a management scenario emphasizing ecologically based and wildfire protection management.

Project	Bodie Hills						
Conservation Target	Aspen (stable)						
Objective	Improve ecological condition of ~2000 acres of Bodie Hills aspen from 41% departure (FRCC 2) to 33% departure (FRCC 1) from NRV and reduce "No Aspen" classes by ~50%… over 20 years						
Acres Treated/Year						50	
Total Ecosystem Acres						1,880	
Strategy	Treat 50 acres/year of late succession aspen classes, provide fencing for 200 uncharacteristic acres and continue active herd management						
Actions			One Time Costs	Acres/Year	Cost/Acre	Cost/Year	
	Burn (or mechanically treat) 50 acres/year of Class E to convert to early succession Class A & B			50	$ 200	$ 10,000	
	Provide temporary fencing over time of DPL Class to convert to Classes B & E			38	$ 200	$ 7,520	
	Continue active herd management to keep livestock away from groves to degree possible for 3 months			1,880	$ 2	$ 4,324	
						$ -	
						$ -	
	Archeological & plant surveys			50	$ 70	$ 3,500	
Total Cost/Year	excluding one time costs		$ -			$ 25,344	
Number of Years						20	
Notes	Model runs indicate annual fencing and 50 acres/year of prescribed fire produces better outcome						

Photos: Susan Abele

Table excepted from: Provencher, L., G. Low, and S. L. Abele. 2009. Bodie Hills conservation action planning: final report to the Bureau of Land Management Bishop field office. The Nature Conservancy, Reno, NV.

LANDFIRE used the model description documents to help map BpS and the VDDT models to determine the pre-settlement reference conditions for calculating FIRE REGIME CONDITION CLASS (FRCC). FRCC is an index representing the difference between reference conditions and current conditions (Figure 3). Here, reference conditions refer to the vegetation composition and structure within each succession class of a particular BpS and the modeled percentage of each succession class on the landscape.
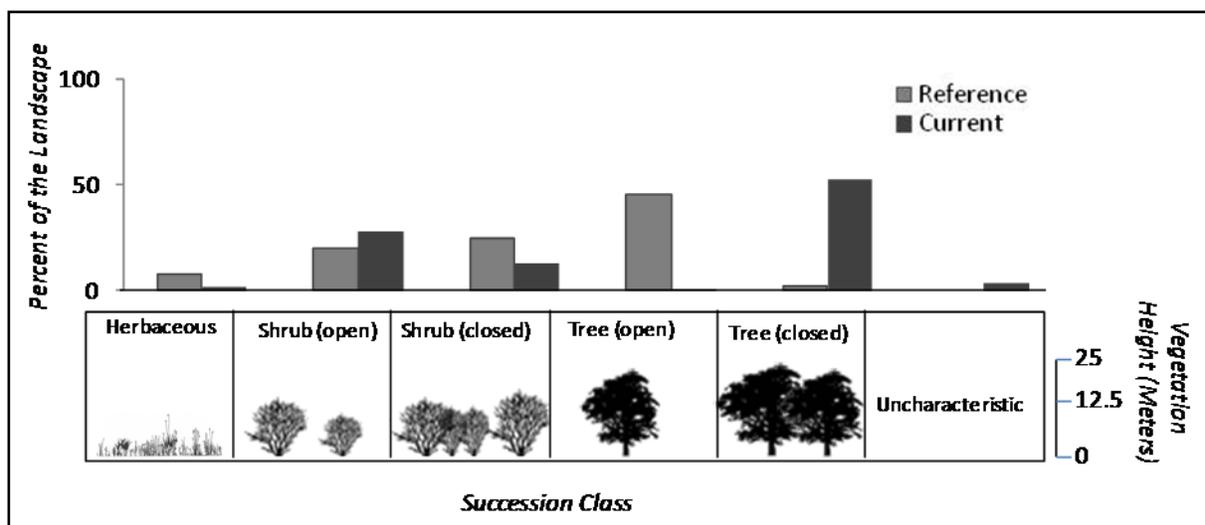

Figure 3. An example of reference and current conditions within the five succession classes of an Oak Woodland BpS. The description document contains the specific information about vegetation height, cover and composition used to define each succession class. The percent of the landscape within each succession class under reference conditions was estimated by running the state-and-transition model in VDDT. The percent of the landscape within each succession class currently was mapped using satellite imagery and plot data.

In addition to their uses by the LANDFIRE project, the models and description documents may be used to:

1. test the potential effectiveness of management strategies such as prescribed fire, thinning and planting. When coupled with cost estimates, models can form the basis of return on investment computations.
2. project future landscape conditions.
3. determine desired future conditions.
4. comply with Forest Stewardship Council and other forest certification programs,
5. develop NEPA alternatives.
6. explore potential climate change impacts.

The "Case Studies" section below provides example of many of these model applications.

LANDFIRE vegetation models were developed to represent the average conditions for a BpS in a Map Zone (Figure 4). For example, one Northern Hardwoods forest model was developed for Map Zone 51. Within the Map Zone the BpS extends from the northern Lower Peninsula of Michigan to the western Upper Peninsula. While this is appropriate for the large scale efforts of LANDFIRE, the models should be reviewed and potentially modified if they are to be used at finer scales. Furthermore, LANDFIRE models and descriptions represent pre-settlement reference conditions and generally require modification to capture conditions on current and future landscapes.

Figure 4: National Land Cover Database (NLCD) map zones used by LANDFIRE.

Why Modify

Users may want to modify LANDFIRE models for several reasons, including
1. to incorporate local data.
2. to represent a broader or finer vegetation concept.
3. to represent current or desired conditions.
4. to include current or potential management activities and/or alteration of natural disturbance regimes (e.g. fire suppression).
5. to use as a collaborative learning tool.

A careful review of LANDFIRE's existing models will help users to determine what they need to change.

Reviewing an Existing Model

Download Models

LANDFIRE vegetation models are available from the VEGETATION DYNAMICS MODELS section of the LANDFIRE website. Models are delivered in two different formats (Figure 5):

1. Description document only. Suggested for users who only need to learn about BpS reference conditions or who want to explore the potential utility of the BpS concept.

2. Description document and state-and-transition models. Necessary for users who need to adjust reference conditions, who plan to create current or future condition models or who want specific reference disturbance information that is not in the descriptive document.

Choose the format that best meets your needs.

> **Need help finding the right model?**
>
> Download the MODEL SEARCH SPREADSHEET to help identify candidate LANDFIRE models. The spreadsheet allows users to search models by dominant vegetation, vegetation type, map zone and fire regime group. Search instructions are included on the first worksheet of the workbook.

Option1: Description Document

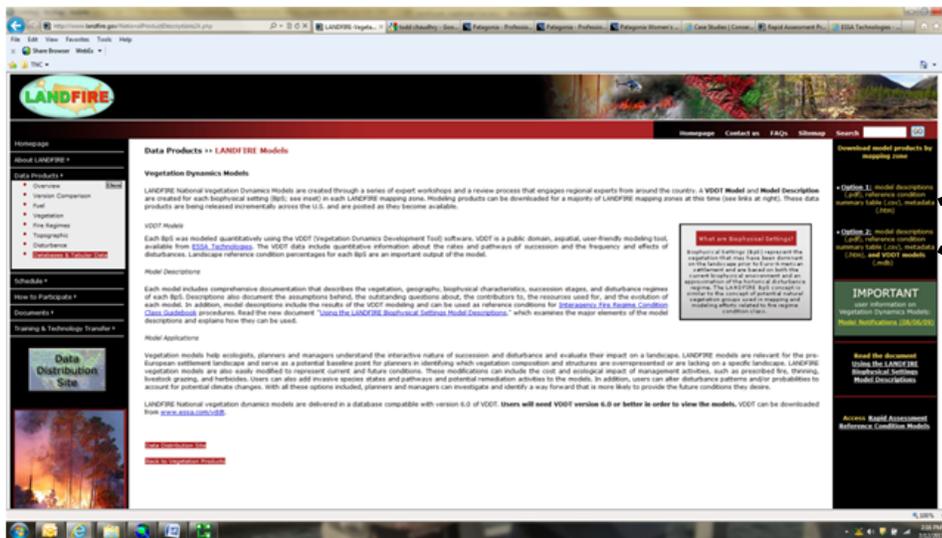Option 2: Description Document and State-and-Transition Models

Figure 5. LANDFIRE models can be downloaded by map zone in two formats: 1) description document only and 2) description document and state-and-transition models.

Review the Model Description Document

Begin the review by reading the model description document to understand how the model was conceptualized and any limitations encountered or assumptions made during the modeling process.

If you are not already familiar with LANDFIRE models, you may want to start by reviewing the document USING THE LANDFIRE BIOPHYSICAL SETTINGS MODEL DESCRIPTIONS which examines the major elements of the model descriptions and explains how they can be used.

❑ Review the metadata document that is downloaded with the models to understand the fields in the description document.

❑ Carefully consider the geographic information during review. Remember that LANDFIRE developed its products zone by zone and it is possible that the same systems could have different models in different zones. After reviewing a model, if it does not fit the particular system, try reviewing the same BpS model from an adjacent zone. In some cases it may be more applicable.

❑ Pay close attention to how each vegetation succession class was defined. The structure data is particularly important. Remember that LANDFIRE modelers were limited to defining classes that could be mapped from satellite imagery. When not restricted to mapable classes, or when have finer resolution mapping capabilities are available, users may want to define these classes differently.
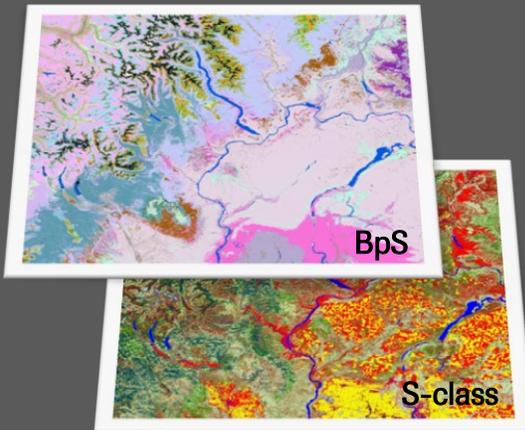
❑ Check the Model Notifications as some models may have identified issues and/or have been updated.

❑ LANDFIRE vegetation modeling units are based on NatureServe's Ecological Systems. Use the NATURESERVE EXPLORER, a searchable online database, to get detailed information on each Ecological System.

❑ Review the BpS and Succession Class maps to learn more about the geographic extent of a BpS within a given Map Zone (more information below).

Matching the Model Description Document with the Spatial Data

Every LANDFIRE vegetation model has corresponding spatial data to represent the geographic extent of the BpS and the current distribution of the succession classes. The spatial data are often used in conjunction with the model for review purposes or further analysis. If you need succession class information, it is generally helpful to use the *combine* function in ArcGIS to overlay the BpS and S-class layers so that the classes are associated with the appropriate BpS (LEARN HOW – WATCH A VIDEO DEMO).

BpS

S-class

Once the datasets are overlaid you can review the information used to map the succession classes by looking at the "Vegetation Classes" section of the model description document. Lifeform, height and cover were the primary criteria for mapping the classes although indicator species were also used to a lesser extent.

Use the vegetation model description document in combination with the BpS and S-class grids to understand the current extent of a BpS and associated S-classes in addition to the BpS reference conditions.

Indicator Species   Lifeform   Height and Cover

Review the State-and-Transition Model

To review the state-and-transition model you will need to install the VEGETATION DYNAMICS DEVELOPMENT TOOL (VDDT) or PATH LANDSCAPE MODEL (Path; ApexRMS and ESSA Technologies Ltd.) on your computer. LANDFIRE vegetation models were created in VDDT but can also be used in Path. Like VDDT, Path is a free software tool and is supported by online documentation. Path maintains nearly all the functionality of VDDT with many additional functions such as the ability to transition between BpS and enhanced model editing features. In the future, VDDT will not be supported, so users are encouraged to migrate to Path. In this section we assume that users have a basic understanding of VDDT or Path.

❑ Review the deterministic or successional pathways using the Redisplay Pathways function (select Redisplay Pathways from the Diagram dropdown menu, then Select Deterministic Transitions).

❑ Review the rates and pathways for the probabilistic or disturbance transitions by opening the Probabilistic Transitions box (select Probabilistic Transitions from the Diagram drop down menu).

❑ Run the model (select Start Model from the Run drop down menu) and graph the results. LANDFIRE models are set to run 10 simulations. To save time while exploring, decrease the number of simulations (select Settings from the Run drop down menu and enter the number of simulations on the General tab). Use the graphing options to explore the results (select Graph Results from the Run drop down menu).

❑ If "other" disturbances are modeled, review the "Disturbances" section of the description document to find out how "other" is defined.

❑ When modifying a model, users are not limited to five boxes (classes) as LANDFIRE modelers were. Further modelers can remove existing disturbances or add new ones.

Modifying a Model

ADAPTING LANDFIRE VEGETATION DYNAMICS MODELS provides a step-by-step guide on how to modify models to represent current and future landscapes. Once adapted, these models may be useful in predicting future vegetation conditions, exploring the impacts of potential environmental changes and comparing the results of different management options.

> **Potential modifications to state-and-transition models might include:**
>
> - Creating an invasive plant dominated succession class.
> - Adding management activities such as thinning, planting or prescribed fire.
> - Turning off or significantly limiting fire to mimic fire suppression.
> - Increasing pest infestation or fire frequency over time to simulate potential climate change scenarios.
> - Adding temporal multipliers to simulate natural variability or the effects of climate change.

Special Considerations

Other Reference Condition Models

In addition to LANDFIRE models, consider using models developed as part of the LANDFIRE RAPID ASSESSMENT and FIRE REGIME CONDITION CLASS GUIDEBOOK projects.

LANDFIRE Refresh Models

LANDFIRE used a collapsed set of vegetation models to create the LANDFIRE 2001 Refresh (LF_1.0.5) and LANDFIRE 2008 Refresh (LF_1.1.0) FRCC products (FRCC, FRCC Departure Index, Fire Regime Groups, Mean Fire Return Interval, Percent Low, Mixed and Replacement Severity and Succession Class). Models were collapsed if the state-and-transition models:

- were identical (i.e. the same BpS, with the same model but in different map zones),
- were similar and had the same fire regime group,
- had the same or a similar number of succession classes (e.g. a 4 box model could be collapsed with a five-box model if the only difference was that the 5th box was for a very rare state, i.e. 1% of the landscape) –AND-
- had similar reference conditions (i.e. similar distribution of succession classes).

When models were collapsed, one of the LANDFIRE National (LF_1.0.0) models was chosen to represent the group and a new group name and number were assigned in the GroupModel and GroupID fields respectively of the BpS map. The Bps_name and Bps_model fields in the BpS map correspond to the LANDFIRE National (LF_1.0.0) model set. FRCC assessments using the LANDFIRE 2001 or 2008 Refresh (LF_1.0.5 or LF_1.1.0) Succession Class dataset must also use the GroupModel field in the BpS dataset.

Climate Change

LANDFIRE models have been adapted to simulate the effects of climate change although the techniques are still experimental. See "Case Studies" below for more information on how this has been done.

Additional Resources

Training

LANDFIRE CONCEPTS, DATA, AND METHODS VERSION 2.0 -- Lesson 5: Biophysical Settings & LANDFIRE Non-Spatial Data

Case Studies

Comparing selected fire regime condition class (FRCC) and LANDFIRE vegetation model results with tree-ring data [reconstructed reference conditions, LANDFIRE data evaluation]

Determining forest fuel treatments for the Bitterroot Front using VDDT [fuel treatment, alternative management scenarios]

Dynamic vegetation modeling: driving management changes today by looking into the past and future [decision support, land management, collaboration, alternative management scenarios]

Enhanced conservation action planning: assessing landscape condition and predicting benefits of conservation strategies [conservation planning, return on investment, ecological condition]

Evaluating the ecological sustainability of a ponderosa pine ecosystem on the Kaibab Plateau in Northern Arizona [modifying LANDFIRE models, climate change]

Forecasting the response of terrestrial habitats to climate change in the Northern Sierra: climate adaptation strategies for the Northern Sierra Partnership [conservation planning, climate change, conservation strategies, climate adaptation, return on investment, ecological condition]

Great Basin land management planning using ecological modeling [resource management plan, land use planning, restoration, alternative management scenarios]

Projecting landscape conditions in southern Utah using VDDT [alternative management scenarios, restoration]

Vegetation dynamics models & FRCC to support ecological assessments [forest plan revision, ecological assessment, modifying LANDFIRE models]