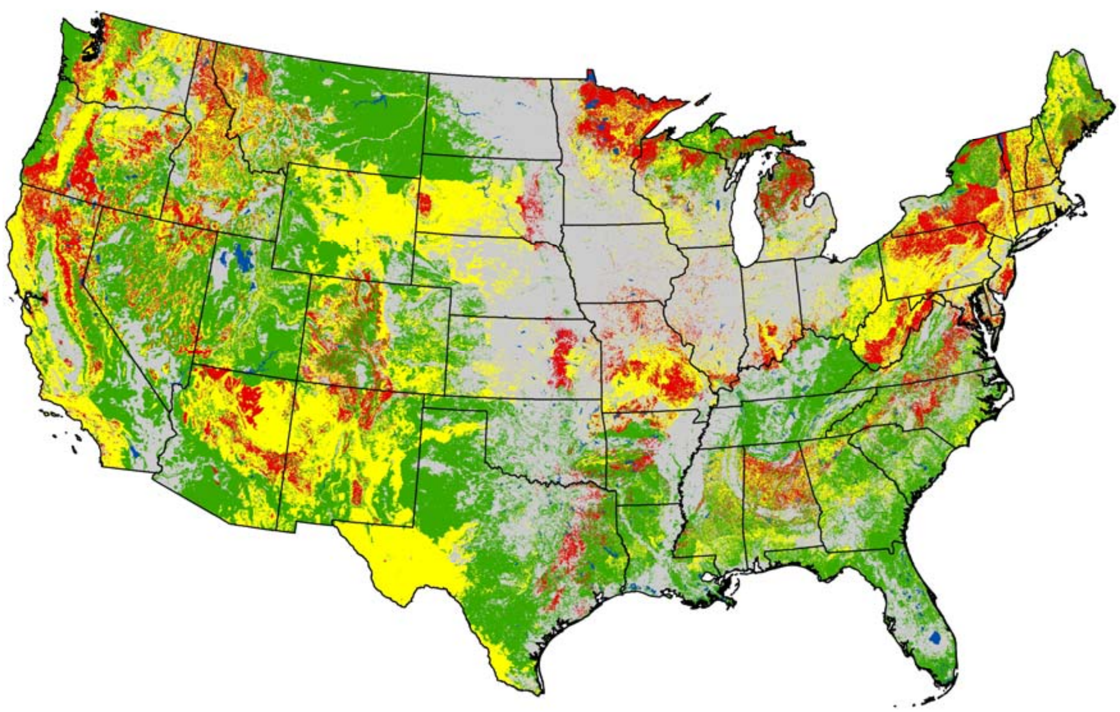


Interagency
Fire Regime Condition Class (FRCC)
Guidebook

Version 1.3.0

June 2008

Abstract

The Fire Regime Condition Class (FRCC) Standard Landscape Worksheet Method and Mapping Method provide tools for fire regime and vegetation assessment at the landscape and stand levels. These methods are used to describe general fire regime and vegetation traits for the historical (reference) versus current periods to produce departure estimates that can be classified as follows. FRCC 1 represents ecosystems with low (<33 percent) departure from a defined reference period – that is, landscapes still within the natural or historical range of variability; FRCC 2 indicates ecosystems with moderate (33 to 66 percent) departure; and FRCC 3 indicates ecosystems with high (>66 percent) departure from reference conditions. The Interagency Fire Regime Condition Class Guidebook applies – at a finer scale and with minor refinements – the original FRCC concepts and definitions published in Hardy and others (2001), Hann and Bunnell (2001), and Schmidt and others (2002). Both the FRCC field and mapping assessment methods were developed and implemented by an interagency working group teamed with The Nature Conservancy and managed by the National Interagency Fuels Coordination Group. The FRCC methods, software, website, and associated publications have been developed in association with the Fire Monitoring and Inventory System (FIREMON) and in parallel with the LANDFIRE Project.

The FRCC Guidebook includes two procedures for determining FRCC: the FRCC Standard Landscape Worksheet Method and the FRCC Standard Landscape Mapping Method. FRCC Guidebook methods were designed to provide consistency and quantifiability from the landscape level to the stand level. The FRCC worksheet and mapping methods also include procedures for assessing stands to help satisfy treatment reporting requirements contained in the National Fire Plan Operations and Reporting System (NFPORS).

The FRCC Guidebook provides step-by-step instructions for conducting assessments with the FRCC Standard Landscape Worksheet Method and an overview of the FRCC Mapping Tool GIS software used for the Standard Landscape Mapping Method. The Standard Landscape Worksheet Method explains not only how to assess FRCC with local field data, but also how to select an appropriate FRCC assessment medium. That is, users can choose from among several assessment approaches, using the Standard Landscape Worksheet, the Standard Landscape Worksheet Field Form, the FRCC Simple-7 Form (all in Appendix A), the FRCC Software Application (FRCCSA), or the FRCC Mapping Tool (FRCCMT). Regarding user support, reference condition models, data entry forms, and associated FRCC software can be downloaded from www.frcc.gov or www.landfire.gov, and an FRCC helpdesk is maintained at helpdesk@frcc.gov.

Certain photos courtesy of Fire Management Today

FRCC Guidebook Version 1.3.0 Highlights

Following is a list of changes that have occurred since FRCC Guidebook version 1.2.0 was released in May 2005.

- **Refined FRCC Concepts/Principles/Methods:** Although FRCC concepts, principles, and methods have not changed substantially, version 1.3.0 addresses issues raised about FRCC concepts, science background, and methods (see chapters 2 and 4 and Appendix C).

- **New Reference Condition models:** A new set of FRCC Guidebook Alaskan reference condition models were developed between 2006 and 2007 (see Chapter 2). In addition, the LANDFIRE vegetation, wildland fuel, and fire regime mapping project has produced numerous reference condition models since 2005, constituting a substantial refinement of the original FRCC Guidebook models. Note that LANDFIRE models are released upon completion of each mapping zone across the U.S., and the scheduled completion of the national mapping process is 2009 (see the Schedule section of www.landfire.gov).

- **Updated terminology**: The previous term *vegetation-fuel class* (VFC) has been changed to *succession class* (S-Class), and some FRCC Mapping Tool layer names have also been updated (see chapters 3, 4, and the Glossary).

- **Updated Glossary:** The FRCC glossary has been updated and expanded.

- **Refined Fire Regime Groups**: The severity definitions for several fire regime groups have been broadened to more adequately reflect natural variation (see Chapter 2).

- **Refined Analysis Scales:** Recommended analysis scales for each fire regime group have been refined (see chapters 2 and 4).

- **Updated FRCC Standard Landscape Worksheets:** Worksheets, field forms, and associated summary graphs have been updated (see Appendix A and Chapter 3).

- **Updated FRCC Software Application (version 1.3.2.4):** The FRCC Software Application has been updated with the new terminology and now provides three sets of default reference condition models for conducting FRCC assessments (see chapters 2 and 3). Users can download the latest software version at www.frcc.gov.

- **Updated FRCC Mapping Tool and User Guide:** A new version of the FRCC Mapping Tool (2.2.0) for ArcGIS 9.2 will be released late 2007 / early 2008, and a new FRCC Mapping Tool User Guide is now available (see Chapter 4 and www.frcc.gov).

- **Updated References**: Numerous additional literature citations have been inserted throughout the guidebook text and in the References section.

- **Overview of LANDFIRE FRCC Geospatial Products**: The LANDFIRE Project has produced several sets of GIS maps related to FRCC. For example, biophysical settings (BpS) and succession classes (S-Class) layers are now available across much of the U.S., as are subsequent maps showing fire regimes and FRCC (see Appendix D and www.landfire.gov for details).

Chapter 1: Overview

Introduction

The Fire Regime Condition Class (FRCC) Standard Landscape Worksheet Method and Mapping Method (using the FRCC Mapping Tool) provide tools for fire and vegetation assessment at the landscape and stand levels. These methods are used to describe general landscape fire regime and vegetation characteristics. Estimates of current characteristics are calculated for comparison with estimates of natural fire regime reference values and reference condition vegetation characteristics. Subsequent departure values can then be determined, ending with a three-tier FRCC classification as described below. The data collected through these methods describe the size of the area being assessed, its geographic location, biophysical conditions, and fire regime characteristics.

The above fire and vegetation variables can be evaluated at different scales, from entire landscapes to individual stands or patches. (Note: Although the term *patch* is generally used in conjunction with shrublands and grasslands, the term *stand* will be used throughout this document when referring to small-scale units of relatively homogeneous vegetation). In FRCC methodology, a landscape is defined as the contiguous area within a delineation that is large enough to include the variation in vegetation conditions of the natural fire regimes. For FRCC purposes, assessment landscapes are referred to as *project areas* that are then subdivided into *strata*, which are subdivisions of the landscape based on biophysical settings (BpS) or fire regime groups as described below. Finally, each stratum is delineated according to *succession classes*, which represent discrete units of early, mid, or late successional vegetation that can be quantified to measure possible departure from the reference period to the current period.

> ***Note***: The term *succession class* [S-Class] has replaced the term *vegetation-fuel class* (veg-fuel class; VFC) used in previous versions of the FRCC Guidebook (Hann and others 2004). This terminology change was made in order to be consistent with terminology used by the national LANDFIRE Project [see www.landfire.gov and Appendix D]).

The FRCC worksheet and mapping methods were designed to provide consistency and quantifiability from the landscape level to the stand level and to allow for quick FRCC estimates of project areas that are closely similar to those previously assessed using the FRCC Standard Landscape Worksheet Method or Mapping Method (guidelines regarding appropriate use of estimation techniques can be found in Chapter 3).

It is important to note that, before determining stand-level FRCC, landscapes must first be assessed using the Standard Landscape Method – either non-spatially via field estimation and accompanying worksheets (Chapter 3 and Appendix A), or by using the FRCC Mapping Tool GIS software (Chapter 4). In either case, the Standard Landscape Method provides the user with a background understanding of the processes used to determine both landscape and stand FRCC. Furthermore, FRCC must first be determined at the landscape level because outputs from the landscape-level assessment serve as inputs to the stand-level assessment (more on this in Chapter 3).

The current fire regime and vegetation conditions are compared to those of the reference period as estimated through modeling. First, landscape-scale departure and FRCC is determined by evaluating the composition of seven reference condition variables (up to five succession classes plus fire frequency and severity) against those for the current period. Next, stand FRCC can be estimated by determining the current relative amount (which is a classification of departure) compared to reference conditions. See Chapter 2 for a detailed discussion of reference condition concepts and modeling procedures.

Both the FRCC worksheet and mapping methods were initially developed and implemented between 2003 and 2005 by an interagency working group teamed with The Nature Conservancy (TNC). The working group, chartered and managed by the National Interagency Fuels Coordination Group, later evolved into the National Interagency Fuels Technology Team (NIFTT). NIFTT was formally chartered to develop and coordinate FRCC training and certification, and to manage the FRCC website (www.frcc.gov). . The FRCC worksheet method, mapping method, software, website, and associated publications have been developed in association with the Fire Monitoring and Inventory System (FIREMON) and in parallel with the LANDFIRE Project (see www.landfire.gov and Appendix D).

FRCC Objectives

Specific objectives initially established by the interagency working group (through the National Interagency Fuels Coordination Group) guided the development of the FRCC procedures, as described below:

1) Procedures will be designed in conjunction with the fire regimes and associated FRCC descriptors initially defined by Hardy and others (2001) and Schmidt and others (2002), with the purpose of supporting multi-level planning and

monitoring and founded upon a broad-based vegetation and disturbance regime sustainability index (such as FRCC) as described by Hann and Bunnell (2001).

2) Methods will be developed and also emulated by mapping procedures in such a way that users would readily understand the applications of FRCC and associated measures.
3) Procedures will be based on simple calculations, classification, and commonly available data so that users can easily calculate and classify data based on field or map assessments.
4) Standard, quantitative methods will be developed to be flexible in application, rapid yet detailed in determination of estimates, and to result in high confidence. A companion estimation technique will be developed and evaluated to allow faster determinations that will emulate the outcome of the standard quantitative method.
5) Development of the procedures will follow similar concepts and terminology as those of other resource condition measures (for example, watershed, forest, and rangeland health) to facilitate interdisciplinary communication and support an integrated approach to multi-level planning and monitoring.

As stated above, the Standard Landscape Worksheet and Mapping methods apply – at a finer scale – to initial FRCC concepts and definitions (Hardy and others 2001; Hann and Bunnell 2001; Schmidt and others 2002) that were subsequently beta-tested and refined. We thank those who tested the FRCC Guidebook and provided recommendations. We also thank those who participated in the development of the potential natural vegetation groups – now termed (for FRCC and LANDFIRE purposes) biophysical settings (BpS) – used in the FRCC methodology. Descriptions of these can be found at www.frcc.gov and www.landfire.gov. For more information on biophysical settings, see Chapter 2.

Refinements of BpS classifications and associated reference condition characteristics are still on-going as of this writing. For example, since 2004, the LANDFIRE Project has been conducting such revisions through both the Rapid Assessment and National phases of the project by modeling all biophysical settings within major geographic areas across the U.S. with a nationally-consistent scientific process. For more information, see www.landfire.gov or contact the LANDFIRE helpdesk at helpdesk@landfire.gov.

There will also continue to be improvements in associated FRCC tools and user support. For example, periodic FRCC Mapping Tool versions will be released to improve functionality and incorporate updates, and all such update notices will be posted via www.frcc.gov, so check the FRCC website regularly to ensure you have the most recent document and software versions. (Note: certified users and trainers will be notified of updates by email. Users can inquire about certification by contacting the FRCC helpdesk.)

This FRCC Guidebook version 3.1.0 and earlier versions have been revised based on recommendations from a formal science review, results from the LANDFIRE Project, research focused on the FRCC methods and reference conditions, assessments of training and implementation tools, and user feedback.

Data Entry Resources

FRCC data entry and reporting software for both the worksheet and mapping methods can be downloaded from www.frcc.gov. We recommend that users of the Standard Landscape Worksheet Method who have computer capability also use the FRCC Software Application, which is a Java-based data entry and reporting software (requires MS Access 2000 or later version). This custom-designed FRCC software provides an efficient system for storage, filing, data correction, sensitivity testing, and production of finished reports with graphics and photos. Note that users without Internet access but with computer capability can obtain the software by requesting a CD-ROM from their respective agencies or TNC.

Quality Control

To date, no formal mechanism exists for tracking the quality of the various FRCC assessments conducted across the U.S. However, the National Interagency Fuels Technology Team (NIFTT) uses a system of examiner codes in a tracking database that contains information on all certified users and FRCC trainers who have participated in formal FRCC training sessions or who have successfully completed the interactive website or CD-ROM FRCC training. This database not only provides insight into how many qualified individuals are conducting FRCC assessments, but also helps NIFTT communicate with users and provide FRCC updates and tool versioning alerts. In addition to providing user training and certification, we strongly encourage users to employ mechanisms that promote internal quality control, such as 1) using a team approach of qualified vegetation and fire ecology experts when conducting FRCC assessments, 2) soliciting internal and external review comments to improve the quality of FRCC assessments, 3) staying informed of the latest FRCC developments and training opportunities as indicated on www.frcc.gov, 4) taking FRCC refresher courses, and 5) establishing professional web networks such as list serves that can serve as "FRCC chat rooms."

Users can ensure they meet the training requirements or inquire about becoming certified by contacting the FRCC helpdesk at helpdesk@frcc.gov.

Guidebook Structure

The FRCC Guidebook is organized into four chapters: Chapter 1 is an introduction to and overview of the FRCC process, Chapter 2 is a detailed discussion of the theory and principles behind FRCC, Chapter 3 provides step-by-step instructions for using the FRCC Standard Landscape Worksheet Method, and Chapter 4 presents an overview of the FRCC Mapping Tool software used for the Standard Landscape Mapping Method. The Standard Landscape Worksheet Method (Chapter 3) facilitates the determination of FRCC using local field data and can be used with the assessment medium that best suits the user's needs. As described in Chapter 3, the available FRCC media are: 1) the Standard Landscape Worksheet, 2) Standard Landscape Field Form, 3) FRCC Simple-7 Form (all located in Appendix A), and 4) the FRCC Software Application. In addition, the Standard Landscape Mapping Method using the FRCC Mapping Tool (Chapter 4) is designed to emulate the above worksheet method, but this approach provides spatially-specific FRCC outputs. That is, the FRCC Mapping Tool produces multiple spatial layers in a geographic information system (GIS) that correspond to the attributes derived by the Standard Landscape Worksheet Method.

Chapter 2: Fire Regime Condition Class Theory and Principles

FRCC definitions

Fire regimes and fire regime condition classes (FRCC) were originally defined and mapped by Hardy and others (2001), Hann and Bunnell (2001), and Schmidt and others (2002). Most inputs for the FRCC methods were identified through landscape-level FRCC mapping tests and demonstration projects, with substantial modifications based on subsequent informal workshops and field tests. Based upon the above work, FRCC was found to be applicable to virtually any wildland vegetation and fuel setting.

Fire regime

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention but including the possible influence of aboriginal fire use (Agee 1993; Brown 1995). Coarse-scale definitions for natural fire regimes were initially developed by Hardy and others (2001) and Schmidt and others (2002) and subsequently interpreted for fire and fuels management by Hann and Bunnell (2001). The five natural fire regimes are classified based on the average number of years between fires (fire frequency or mean fire interval [MFI]) combined with characteristic fire severity reflecting percent replacement of dominant overstory vegetation. These five natural fire regimes are defined as follows:

Table 2-1a. Fire regime groups and descriptions.

Group	Frequency	Severity	Severity description
I	0 – 35 years	Low / mixed	Generally low-severity fires replacing less than 25% of the dominant overstory vegetation; can include mixed-severity fires that replace up to 75% of the overstory
II	0 – 35 years	Replacement	High-severity fires replacing greater than 75% of the dominant overstory vegetation
III	35 – 200 years	Mixed / low	Generally mixed-severity; can also include low-severity fires
IV	35 – 200 years	Replacement	High-severity fires
V	200+ years	Replacement / any severity	Generally replacement-severity; can include any severity type in this frequency range

> ***Note***: The above regime groups have been modified slightly from earlier versions (Hardy and others 2001; Schmidt and others 2002; FRCC Guidebook Version 1.2.0) to be consistent with the LANDFIRE Project (specifically, Fire Regime III now includes low severity fires and Fire Regime V includes fires of any severity type).

Some users have asked why these fire regime definitions use 25 and 75 percent as severity thresholds between the low, mixed, and replacement regimes, rather than 10 and 90 percent as suggested by previous researchers (Morgan and others 1998; Hardy and others 2001; Schmidt and others 2002). Field reconnaissance by fire ecologists during the FRCC beta testing period suggested that 25 and 75 percent thresholds are more realistic, whereas the 10 and 90 percent thresholds were largely theoretical. For example, although most experts would agree that landscapes heavily dominated by even-age stands without fire scars should be classified as a replacement regime (Brown 1995; Brown and Smith 2000), field reconnaissance often reveals that such fires commonly produce less than 90 percent replacement of dominant overstory vegetation. This interpretation is generally supported by Brown and Smith's (2000) "Fire Effects on Flora" fire ecology compendium (otherwise known as the "Rainbow Series").

Fire regime condition class

Fire regime condition classes measure the degree of departure from reference conditions, possibly resulting in changes to key ecosystem components, such as vegetation characteristics (species composition, structural stage, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances, such as insect and disease mortality, grazing, and drought. Possible causes of this departure include (but are not limited to) fire suppression, timber harvesting, livestock grazing, introduction and establishment of exotic plant species, and introduced insects and disease (Schmidt and others 2002).

The three fire regime condition classes are categorized using the following criteria: FRCC 1 represents ecosystems with low (<33 percent) departure and that are still within the estimated historical range of variability during a specifically defined reference period; FRCC 2 indicates ecosystems with moderate (33 to 66 percent) departure; and FRCC 3 indicates ecosystems with high (>66 percent) departure from reference conditions (Hann and Bunnell 2001; Hardy and others 2001; Schmidt and others 2002). As described below, departure is based on a *central tendency* (or mean) metric and represents a composite estimate of the reference condition vegetation characteristics; fuel composition; fire frequency, severity, and pattern; and other associated natural disturbances (see the Reference Condition Modeling section below for an explanation of central tendency). Low departure includes a range of plus or minus 33 percent deviation from the central tendency.

Characteristic vegetation and fuel conditions are considered to be those that occurred within the natural fire regime, such as those found in areas categorized as FRCC 1 (low departure). Uncharacteristic conditions are considered to be those that did not occur within the natural regime, such as areas that are often categorized as FRCC 2 and 3 (moderate to high departure). These include (but are not limited to): invasive species (weeds and insects), diseases, "high graded" forest composition and structure (in which, for example, large fire-tolerant trees have been removed and small fire-intolerant trees have been left within a frequent surface fire regime), or overgrazing by domestic livestock that adversely impacts native grasslands or promotes unnatural levels of soil erosion.

Users should note that FRCC is strictly a measure of ecological trends and not a fire hazard metric. Nonetheless, inferences about current fire hazard can sometimes be made after examining FRCC outcomes. For example, a savanna biophysical setting (BpS) heavily invaded by trees as a result of fire exclusion would often be considered to reflect both FRCC 3 and high fire hazard. Similarly, FRCC might serve as a proxy for predicting second-order fire effects (Keane, personal communication). Examples include FRCC 3 scenarios where uncharacteristically severely burned sites are expected to develop high vulnerability to soil erosion, insect outbreaks, or invasive weeds.

To estimate departure and resultant fire regime condition class, reference condition characteristics have been identified and written descriptions developed for biophysical settings (BpS) across the western U.S., eastern U.S., Alaska, and Hawaii. (Note, however, that the LANDFIRE Project likely will not complete the Hawaiian BpS models until 2008 or 2009). Specifically, a series of increasingly refined BpS models have been developed to describe succession class (S-Class; previously termed *vegetation-fuel class* in FRCC Guidebook Version 1.2.0) composition, fire frequency, fire severity, and other important BpS traits. This step-wise process will be described in detail below, but the goal was to refine the relatively coarse BpS models that were originally created by the FRCC Working Group between 2002 and 2005. The reference condition characteristics for each BpS can be found in summary tables of reference values extracted from each BpS description document, organized according to each major region of the U.S. described above. Description documents are comprehensive summaries of each BpS. Both the reference condition summary tables and the BpS description documents can be found on the FRCC website at www.frcc.gov and at www.landfire.gov. These values were developed through Vegetation Dynamics Development Tool (VDDT) modeling (Beukema and others 2003a), literature reviews, field visits, and communication with regional experts (additional details on biophysical settings and reference conditions are provided below).

Refinement of reference condition models will be ongoing through 2009 via expert workshops and the LANDFIRE Project. In addition, through workshops, biophysical settings will be identified at finer resolutions and models will incorporate more expert input and peer-review. (Finer resolution reference condition models can be developed through regional or local efforts but must be conducted using a standardized guidebook process – see Appendix B). For information on workshops or to ensure you have updated values, visit the FRCC and LANDFIRE websites (www.frcc.gov, www.landfire.gov) or contact the FRCC helpdesk at helpdesk@frcc.gov.

FRCC definitions summary

- A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention but including the possible influence of aboriginal fire use.
- The five natural fire regimes are defined as follows:

Table 2-1b. Fire regime groups.

Group	Frequency	Severity
I	0 – 35 years	Low / mixed
II	0 – 35 years	Replacement
III	35 – 200 years	Mixed / low
IV	35 – 200 years	Replacement
V	200+ years	Replacement / any severity

- Fire regime condition classes measure the degree of departure from reference conditions.
- The three fire regime condition classes are categorized using the following criteria: FRCC 1 represents ecosystems with low (<33 percent) departure and that are still within the estimated historical range of variability during a specifically defined reference period; FRCC 2 indicates ecosystems with moderate (33 to 66 percent) departure; and FRCC 3 indicates ecosystems with high (>66 percent) departure from reference conditions
- Reference condition characteristics have been identified and written descriptions developed for biophysical settings (BpS) across the U.S. Both the reference condition summary tables and the BpS description documents can be found on the FRCC website at www.frcc.gov.

Biophysical settings

Biophysical settings (BpS) are the primary environmental descriptors used for determining a landscape's natural fire regimes, vegetation characteristics, and resultant FRCC category. Biophysical settings incorporate both classification (taxonomic) and map unit concepts. Ecosystems can be classified based on a single attribute, such as vegetation, soils, or geomorphology, or they can be classified based on integrated attributes, such as ecological types (Winthers and others 2005), ecological sites (NRCS 2003), or ecological systems (Comer and others 2003). For FRCC purposes, biophysical settings use dominant vegetation types and their associated fire regimes as a proxy for the integration of a landscape's biotic and abiotic components. Biophysical settings can often be described according to their respective fire regimes and associated vegetation composition (native overstory species) and structures (major successional stages) based on the best available research describing historical ranges of variation (HRV). Therefore, BpS classifications such as those used by the national LANDFIRE Project provide a useful foundation for determining FRCC. (For more information on the BpS classification and mapping conducted by LANDFIRE, see www.landfire.org and www.natureserve.org).

Modeling biophysical settings

For FRCC purposes, biophysical settings (BpS) are modeled based on succession classes (S-Class), which are characterized by unique compositional and structural traits. A visual dynamics model, called the 5-box model, is used to characterize these S-Class traits and the associated successional pathways for each BpS (figs. 2-1 and 2-2) in response to growth, maturation, and periodic disturbances. For any given stand, note that only one S-Class can occur at a time. However, multiple succession classes (that is, many stands) can occur simultaneously across a given BpS. This type of successional dynamics model was developed and peer reviewed for each BpS during both the original FRCC Guidebook modeling effort and continues to be developed and reviewed through LANDFIRE modeling workshops. Note that not all biophysical settings conform to the standard 5-box model. For example, some grassland types might have only two or three succession classes, and some classes might have age and canopy characteristics different from those in the standard 5-box models shown below.

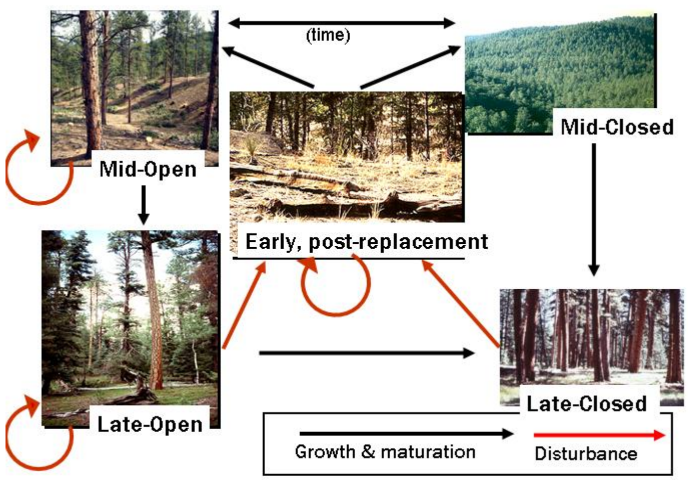


Figure 2-1. Visual dynamics model (standard 5-box) for a forest ecosystem.

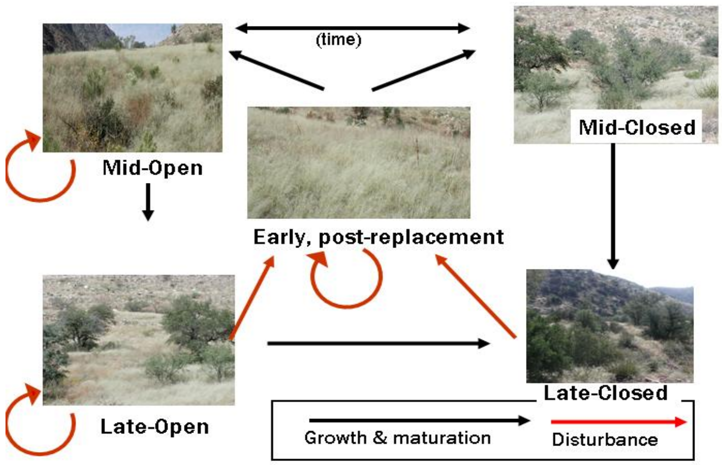


Figure 2-2. Visual dynamics model (standard 5-box) for a rangeland ecosystem.

In summary, the five characteristic succession classes in the standard 5-box model are: 1) S-Class A: early-seral, post-replacement (previously also known as Class AESP in Guidebook Version 1.2.0); 2) S-Class B (previously BMSC), which represents a mid-seral, closed canopy condition; 3) S-Class C (previously CMSO), which represents mid-seral, open canopy stands; 4) S-Class D (previously DLSO), which represents late-seral, open canopy stands; and 5) S-Class E (previously ELSC), which represents the late-seral, closed canopy condition. Users must remember, however, that not all BpS models conform to the 5-box model, so the detailed model descriptions (available from www.frcc.gov and www.landfire.gov) should always be consulted before attempting to conduct an FRCC assessment.

Vegetation as a proxy for biophysical setting

Although biophysical settings represent the collective, integrated attributes of an environment, we use vegetation as a proxy to describe them. The BpS is typically identified by vegetation indicating the mix of fire severity and frequency across the landscape. For example, grand fir (*Abies grandis*) is often associated with a mixed-severity fire regime, and ponderosa pine (*Pinus ponderosa*) with a frequent, low-intensity fire regime. However, it should be clearly understood that, for the purpose of assessing fire regime and fuel conditions, vegetation is a practical surrogate for the BpS but not a concise classification of vegetation or ecologically-integrated map units.

Vegetation for both forests and rangelands can be defined in *existing*, *potential*, and *historical* terms and can be classified and mapped at all scales (they are not limited to local plant associations).

Existing vegetation is the plant cover, or floristic composition and vegetation structure, occurring currently at a given location (Brohman and Bryant 2005). Existing vegetation's departure from the composition and structure of the reference conditions is used to calculate FRCC.

The term *potential natural vegetation* (PNV) refers to vegetation that would become established if all successional sequences were completed and reflects the capability of an area to generate a characteristic set of ecosystem structure, function, and composition. Unfortunately, the term is often confusing because it has been defined in different ways with various nuances. Two basic concepts of PNV have emerged, the first definition excluding disturbance and the second including disturbance: 1) the successional sequence is constrained only by climate, meaning succession proceeds to a climax state limited only by the climatic regime affecting the area (Winthers and others 2005) and 2) succession proceeds until a characteristic disturbance (often fire) occurs, reverting the ecosystem to a previous successional stage (NRCS 2003).

Inclusion of disturbance in defining the vegetation component of the BpS is critical for FRCC determination since fire regime condition class is based on an estimate of departure from the reference condition of vegetation states and their interrelationships with fire frequency, fire severity, and other disturbances across landscapes. FRCC methodology therefore employs the concept of potential natural vegetation defined as that limited by disturbance, not climate. For FRCC purposes, ecological classifications that use climate-constrained PNV require a crosswalk to relate those PNV types to the biophysical settings used in FRCC assessments.

Many existing classifications of potential natural vegetation are in use, and although somewhat simplistic in presentation, table 2-2 is useful for comparing and understanding commonly used approaches to classifying potential natural vegetation.

Table 2-2. Examples (and associated references) of potential natural vegetation classifications grouped according to whether natural disturbance is incorporated.

Vegetation classification approach	Classification examples	Reference
Excluding natural or historical disturbance (vegetation constrained only by climate)	Habitat type and climax plant association Potential vegetation type Potential natural vegetation	Daubenmire 1968 Keane and others 1996 Winthers and others 2005
Including natural or historical disturbance	Kuchler potential natural vegetation Ecological site classification Ecological systems	Kuchler 1964 USDA Natural Resource Conservation Service 2003 Comer and others 2003

Historical vegetation is the vegetation that existed during the reference period prior to Euro-American settlement, and such ecosystems were sometimes influenced by Native American fire use (Barrett and Arno 1982; Gruell 1985; Barrett and Arno 1999; Boyd 1999; Vale 2002; Mann 2006). The starting point of Euro-American settlement varies throughout the United States, from the early 1600s in coastal Virginia and New England to the late 1700s in the Appalachians to the late 1800s throughout much of the Northern Rockies and the Pacific Northwest. For this reason, the length of the reference period for describing historical vegetation varies according to geographic location. For the Interior Columbia Basin assessment, for example, a time frame of 400 years, from 1450 to 1850 (the latter being the approximate date of settlement) was used (Keane and others 1996; Quigley and Arbelbide 1997). For FRCC determinations, we use historical vegetation for reference conditions because we lack understanding regarding the way historical systems would currently operate under present climatic and edaphic conditions.

Use of the historical range of variation from the period prior to Euro-American settlement to describe reference condition vegetation is sometimes criticized by managers and scientists because the climate during that period was cooler than today's climatic trends. For this reason, if data are available regarding the mix of successional stages without modern human interference in today's climate, these should be used. In most cases, however, this information is lacking, and thus the historical range of variation usually provides our best understanding of functioning landscapes with the full array of ecosystem structure, composition, and processes. In short, these historical landscapes are what we know was functioning and sustainable, and FRCC estimates the current departure from those conditions. Moreover, using the current range of variation in ecosystems also has its weaknesses: until we improve our ability to predict near future (30-100 years from present) vegetation dynamics, this approach will remain largely speculative. Also, use of current conditions as a baseline for determining reference conditions may inadvertently lead to a belief that current, degraded environments are acceptable.

Biophysical settings summary

- BpS is the primary landscape delineation for FRCC and incorporates both classification and map unit concepts.
- Vegetation is used as the environmental expression of the land's capability – a proxy for describing the biophysical setting.
- FRCC uses a potential natural vegetation concept that incorporates natural disturbance; the incorporation of disturbance is critical in FRCC determination because FRCC is an estimate of the departure from the natural or historical range of disturbance.
- We recognize that the historical range often developed under a different climatic regime than that of today's; therefore, where data are available, we recommend

use of the current (natural) range of variation given lack of modern human interference.

- Existing, potential, and historical vegetation concepts have all been used in developing FRCC methodology. Current conditions are described using existing vegetation. The concept of potential natural vegetation represents the environmental setting and the landscape's capability to generate the structure, function, and composition of ecosystems. This potential land capability, associated with an historical range of variation in disturbance, provides information on historical vegetation, which in turn provides a context for determination of the reference conditions used in FRCC assessments.

Reference Condition Concepts

Reference conditions are defined as the composition of landscape vegetation and disturbance attributes that, to the best of our collective expert knowledge, can sustain current native ecological systems and reduce future hazards to native diversity. Reference conditions should reflect characteristics that can be restored. These conditions are the baseline for determining departure from the natural or historical range. Reference conditions are determined by experts through synthesis of expert knowledge, published literature, and historical information using standardized computer modeling tools and processes. Each iteration of reference condition determination is reviewed and adjusted based on informal or formal peer review to maintain an adaptive approach to incorporating new expert knowledge, information, or modeling tools. Historical empirical data and historical modeling provide an important context for reference condition determination but are only a subset of the inputs for the identification of reference conditions. For example, in some highly altered landscape ecosystems – such as old field systems of the eastern U.S., exotic invasives of the western U.S., loss of whitebark pine (*Pinus albicaulis)* to blister rust (*Cronartium ribicola*) in the West, or loss of grassland soils in the Southwest – the historical context may constitute only a minor factor in determination of reference conditions. For preliminary development of reference conditions, however, modeling of the historical may provide the most efficient means to an initial estimate.

Historical and present natural range of variability

As stated above, reference conditions reflect our best estimate of a sustainable environment. This sustainable environment does not exist as a fixed state, but rather occurs within a range of variation, reflecting the intrinsic instability of landscape patterns (Pickett and White 1985).

Because fire regime condition class uses landscapes as an organizing principle, reference conditions are defined by the mix of vegetation states (succession classes) across the landscape combined with the fire severity characteristic of that landscape. This concept forms the spatial aspect of landscape ecology.

Time, however, is also a critical component affecting the way landscapes function: in addition to severity, the frequency of fires also defines reference conditions. A broad time period (100 to hundreds of years, depending on Euro-American settlement) frames the reference conditions, and within this broad time frame, a range of variation of reference conditions emerges – a range limited by the climate, geology, geomorphology, soils, and vegetation of the landscape: the biophysical setting. Some biophysical settings generate frequent, low-intensity fires; others infrequent, high-intensity fires; and so on.

Reference conditions should therefore be defined in terms of a range of conditions over space and time, rather than in terms of a fixed set of conditions. We see two main approaches for defining the range of variation: the *historical range of variation* and the *present natural range of variation*. Each approach has strengths and weaknesses (table 2-3 below).

In North America, the historical range of variation (HRV) is usually defined by the period prior to Euro-American settlement. (Note: the term *historical range of variation* can also be considered synonymous with *natural range of variation* [Landres and others 1999]). As discussed above, this period would occur prior to 1600 in New England, prior to 1800 in the Midwest, prior to 1850 in the Pacific Northwest, and so on. Typically, the time frame is set as several hundred years prior and up to the particular settlement era. The specific time frame should be carefully defined according to objectives, available data, and ecosystem characteristics (Landres and others 1999).

Using current and historical data (such as those from tree ring analysis), modeling can estimate a landscape's range of variation in seral stages (succession classes), fire frequency, and fire severity. A strength of the historical range concept is that a "track record" exists in the form of historical data – albeit to varying degrees, depending on the landscape of interest – to suggest that landscapes of this time period were, in fact, sustainable. On the other hand, one commonly expressed concern about the HRV concept is that pre-settlement vegetation patterns might reflect a climate somewhat cooler than present conditions, and that climatic factors can override some management actions (Veblen 2003). For example, the Little Ice Age (Bradley and Jones 1993) likely spanned from the mid-11th to mid-19th centuries, and a warm-dry trend has been occurring since that time. Nonetheless, fire regimes for most biophysical settings were likely relatively stable for at least several centuries before attempted fire exclusion (Agee 1993; Swetnam and Baisan 1996; Barrett and others 1997; Frost 1998; Morgan and others 1998; Brown and Smith 2000; Heyerdahl and others 2007) so today's models are acceptable for FRCC purposes (Keane and others 2007; Morgan and others 2007). Also note that BpS models can be edited in the future if climatic or other factors suggest that such editing is merited.

The present natural range of variation (PNRV) is defined by a time period starting at the present and reaching into the future, with the future endpoint typically defined at 100 years and sometimes even up to 500 years (or further). Such modeling is based on a hypothetical future climate, and therefore PNRV could be more useful than HRV (Running 2006; Westerling and others 2006). But this concept also has drawbacks, notably in the inherent speculation about seral stage composition, fire frequency, and fire severity. Moreover, we are uncertain of what will be sustainable in the future.

Table 2-3. Comparison of the Present Natural Range of Variation (PNRV) and Historical Range of Variation (HRV) approaches.

	Historical range of variation (HRV)	**Present natural range of variation (PNRV)**
Time frame	Prior to Euro-American settlement (date varies). Must define the time period (such as 400 years prior and up to settlement).	Current and near future (approximately 100-500+ years).
Climate	Historical climate.	Current climate and modeled future climatic trends.
Human influences	Includes the influence of Native American management activities on the affected landscape patterns. (Prescribed burns and wildfires indistinguishable from fire scar data.)	Incorporates the legacy of Native American activities because much of the current native plant diversity reflects those activities.
Strengths	Empirical data are available from dendrochronology, historical photos, historical surveys, and other historical ecology techniques.	May provide the most realistic baseline from which to assess landscape change and departure. Modeling can integrate expert judgment and current/future simulations with historical empirical data.
Limitations	Reference conditions for landscape assessments would be based on a climate that no longer exists. Rapid warming as the Little Ice Age ended may have created short-lived fire regimes that cannot be confidently extrapolated either forward or backward in time. How do we know what was sustainable under past conditions? Even a 400-year pre-settlement period is shorter than the life span of many tree species.	Data are often lacking on vegetation state trends. It may be difficult to predict state mix on the landscape. Problem of "shifting baselines:" The possible trap of defining what is there today or what we desire as a baseline that may not represent natural or even functional conditions. Selecting reference areas can be difficult, particularly in landscapes highly altered by humans. How do we know what will be sustainable under future conditions? 100 years may be to short for some vegetation state changes to occur.
Possible refinements	Timeframe can vary and must be defined.	Option to include introduced organisms (such as cheatgrass (*Bromus tectorum*), blister rust, chestnut blight (*Cryphonectria parasitica*), and feral horses) that have naturalized.
Interpretive issues	HRV is based on at least some limited data about past conditions plus modeling. It may therefore be less speculative than PNRV. HRV requires careful examination of the available data and comparison of past and present climates.	PNRV is based primarily on modeling because we have no data on future conditions. It therefore may be more speculative than HRV. PNRV requires careful examination of model assumptions and accurate knowledge of species dynamics.

When using HRV and PNRV concepts in practice, we must refine the approach to better address the specific situation being studied. For example, most modelers of the range of variation, both historical and present natural, consider Native American burning an inherent part of the ecosystem that influenced the landscapes we see today. Modelers must also define the numeric boundaries of the reference values to reduce the variation to a workable range; for example, in the Interior Columbia River Basin Assessment, reference values were defined as conditions falling within +/- 25 percent of the historical mean value for an attribute (Hemstrom and others 2001).

Users of PNRV must also decide on two other important refinements: whether to include effects of invasive plants and animals (introduced by humans in the settlement and post-settlement period), and how much human-caused disturbance, resulting from development and agriculture, should be recognized in the reference conditions. We have to decide at what point we accept invasives as a part of ecosystems that cannot be changed. As mentioned in the Biophysical Settings section above, use of current conditions as a baseline for determining reference conditions may inadvertently lead to a belief that current, degraded environments are acceptable. For example, the removal of cheatgrass from the western U.S. may seem daunting, but technology and methods may yet be developed that will make this possible. As a further example, the return of the American chestnut to Appalachian forests, based on advances in breeding disease resistance in the species, does not seem as hopeless as it once did.

We encourage use of PNRV in applying FRCC because it is realistic, having a basis on current conditions and on trends suggesting conditions to come – not on conditions gone forever (NCSSF 2005). Having said this, use of HRV to determine reference conditions must serve as a surrogate in many cases until better data and models are available (Landres and others 1999). Indeed, a review of the literature on the range of variation suggests that all approaches, whether relying on historical, current, or future time frames, are still working within the same basic concept. In other words, they all include elements of the variation in ecological processes and landscape structure defined within a time period prior to Euro-American settlement (Morgan and others 1994; Fule and others 1997; Landres and others 1999; Swetnam and others 1999; Hemstrom and others 2001; Dorner 2002; Wong and Iverson 2004). The careful examination of a wide range of data on vegetation, disturbance, and climate, combined with documentation of all assumptions made, seems therefore preferable to persistent use of a dogmatic time frame and is likely to lead to the best product (Wong and Iverson 2004).

Our understanding of reference conditions is an approximation of reality, and some error will be generated in our fire regime condition class determinations for this reason. Nonetheless, the inherent assumptions made in landscape modeling have been well-documented (Hemstrom and others 2001). In addition, FRCC has proven to be a robust method of departure determination, in part because great precision is not necessary to determine that many of our ecosystems are clearly departed from a sustainable state.

Finally, it should be noted that the range of variation is not the same as the desired future condition. The latter incorporates the human social and economic contexts. Although consideration of these contexts is critical for true sustainability – active ecological restoration will not proceed without society's support – the desired future condition is determined by a statement of policy rather than a scientific principle.

Reference condition modeling

Current standardized FRCC methods for estimating reference conditions for a given BpS use a non-spatial vegetation and disturbance dynamics model called the Vegetation Dynamics Development Tool (VDDT; Beukema and others 2003a). The model is calibrated through review of the literature, expert opinion, and field data, when available. The inputs to the model include: 1) estimates of transition (succession or growth and development) rates between succession classes (states or seral stages) and 2) probabilities (frequencies) of disturbance that maintain a succession class or cause transition from one class to another. This modeling approach is used to integrate empirical data with information from the literature and the knowledge of regional or local experts. To describe reference conditions, we use the *central tendency estimate* rather than a range of variability, such as a minimum and maximum. The literature on historical vegetation and natural fire regimes is not consistent in reporting a range of variation, but is consistent in reporting a central tendency estimate – usually in terms of a mean, such as mean fire interval or mean vegetation condition.

Where spatial data are available, a companion spatial model can be used to determine if spatial variation in factors such as fire weather, fire spread, terrain, and climate may change the reference condition estimates. These companion spatial models include the Tool for Exploratory Landscape Analysis (TELSA) (Beukema and others 2003b) and the Landscape Succession Model (LANDSUM) (Keane and others 2003). However, although the topic has not been studied widely, initial results indicate that reference condition estimates may not be substantially different between simulations using only VDDT versus those including a spatial companion model (Shlisky and others 2005).

Both the FRCC Guidebook models (www.frcc.gov) and subsequently refined models produced by the LANDFIRE Project (www.landfire.gov) estimate reference conditions for long-term simulation periods. The transitions and probabilities of change between succession classes are based on historical evidence unless current climate, soil, or plant species are known to be permanently altered for a given BpS. In cases of permanently altered biophysical settings, the reference conditions are first modeled using the historical evidence and then adjusted for altered changes in states and transitions.

Refer to the Fire Regime Condition Class section near the beginning of this chapter for details on 1) the reference conditions that have been modeled for various regions of the U.S., 2) where to find descriptions and summary tables of the reference conditions, 3) how these were identified and how they are being refined, and 4) how to ensure you have updated values. Note again, however, that the default reference condition models have been continually refined since FRCC Guidebook Version 1.2.0, as follows:

1) Between 2002 and 2005, 186 FRCC Guidebook models were initially developed by the FRCC Working Group (Hann and others 2004) for the lower 48 states and Alaska; also note that a replacement set of 17 models for Alaska was recently developed by Alaskan ecologists. Those model descriptions and associated summary tables will be available at www.frcc.gov by December 2007, as will new versions of the FRCC Software Application and FRCC Mapping Tool databases incorporating these new data.

2) The next modeling refinement effort was the Rapid Assessment phase of the LANDFIRE Project between 2004 and 2005, which produced 231 models for the conterminous 48 states.

3) Finally, the National mapping phase of the LANDFIRE Project refined the Rapid Assessment models and is producing more than 500 models that will eventually cover the conterminous U.S. and Hawaii when completed in 2009.

Note again that written descriptions and summary tables (in .pdf format) for the above models can be obtained from www.frcc.gov. Although any of these models can be used for FRCC assessments, users should bear in mind the above refinement process when evaluating which set of models best fits a given locale.

Reference condition concepts summary

- Reference conditions are an estimate of the mix of succession classes (states or seral stages), fire frequency, and severity across the BpS of interest.
- Reference conditions are the baseline for determining departure from the natural or historical range (fire regime condition class).
- Reference conditions are determined by experts through synthesis of expert knowledge, published literature, and historical information using standardized computer modeling tools and processes.
- We encourage use of PNRV in applying FRCC because it is realistic, having a basis on current conditions and on trends suggesting conditions to come; however, use of HRV to determine reference conditions must serve as a surrogate in many cases until better data and models are available.
- Current standardized FRCC methods for estimating reference conditions for a given BpS use a non-spatial vegetation and disturbance dynamics model called the Vegetation Dynamics Development Tool (VDDT).
- To describe reference conditions, we use the *central tendency estimate* rather than a range of variability, such as a minimum and maximum.

- Refer to the Fire Regime Condition Class section near the beginning of this chapter for further details on the reference conditions used in FRCC determination.

Scale issues and landscape stratification

Definition of scale as used in landscape ecology

As used in landscape ecology, scale refers to the spatial or temporal dimension of an object or process; it is characterized by *both* grain (resolution) and extent (Turner and Gardner 1991). Grain is the finest level of spatial resolution possible within a given data set (for example, the pixel size for raster data). Extent is the size of the study area or the duration of time under consideration. Thus, the scale of LANDFIRE data is 30 square meters (resolution) for the entire country (extent). "Fine scale" refers to minute resolution or a small study area and "broad scale" refers to coarse resolution or a large study area.

In a landscape assessment context, it is best to refer to scale in terms of extent. "Broad" versus "local" are unambiguous and easy to understand by all. In documentation, the area can be quantified, for example, "landscapes of approximately 6,000 to 10,000 acres each were assessed."

For coordinating analyses and communication within a region, we recommend standardizing units to facilitate consistency. For example, standardized units may be 5th or 6th field hydrologic unit codes (HUCs) in the West or landtype associations (LTAs) in the East.

As mentioned above, time has scale too: short-term versus long-term. In the case of time, it is best to state the period of time (days, years, hundreds or thousands of years, geologic epochs, and eras) so it is clearly understood by subsequent users of FRCC data.

Scale as applied in FRCC determination

A key element in accurately evaluating FRCC is an understanding of scale. Much of the work in the realm of natural resources takes place at the stand level; activities such as slash disposal, noxious weed treatment, and biomass removal are all examples of stand-level projects. Although it is possible to analyze individual stands using the FRCC Standard Landscape methods (see Chapter 3), analysis must always start at the landscape level because fire regimes operate at that level.

Note, however, that the FRCC modeling and assessment processes use fire frequency metrics from small representative stands (defined as "cluster scale" by Arno and Peterson 1983) to characterize landscape-scale fire frequency for each BpS. Initially, this may seem counterintuitive because the main goal of the FRCC modeling and assessment process is to characterize fire regimes and associated vegetation conditions for entire landscapes. But representative stand metrics such as mean MFI from multiple sample sites (Barrett and others 1997) allow users to characterize fire frequency for multiple scales. A representative stand MFI, for example, can be used to determine the fire cycle (Heinselman 1973; Heinselman 1981; Brown and Smith 2000) for a given BpS regardless of landscape size (Barrett and others 1997; Morgan and others 1998). To illustrate this concept, assume that one BpS dominates a 10,000-acre (4,047 ha) landscape. Dividing that area by a representative stand MFI of, for example, 10 years yields an average of 1,000 burned acres per year. In contrast, a million-acre (404,700 ha) area dominated by that same BpS would yield an average of 100,000 burned acres per year. Stand MFI thus represents the lowest common denominator for characterizing fire frequency at multiple scales, which is useful because FRCC project landscapes can vary widely in size. (Note that Chapter 3 will discuss the above concept further when explaining how to estimate fire frequency statistics for the reference and current periods).

In FRCC methodology, a project landscape is defined as a relatively large-scale, contiguous area big enough to exhibit natural variation in fire regimes and associated vegetation. Determination of an appropriate size landscape for a given FRCC assessment can often be based on the dominant fire regime groups in that landscape. Fire regimes I and III typically produce relatively fine-grained patch variation within a given BpS polygon that is substantially smaller than the average historical fire size. This is also true for steep, highly dissected terrain, where patch variation is controlled more by topography than fire size. In contrast, mixed-severity regimes in flat to rolling terrain have larger patch variation, which requires landscape assessment areas one to two times larger than the average historical fire size. The infrequent and rare replacement types (regimes IV and V) in steep and dissected terrain might require landscapes two to three times larger than the historical fire size, as opposed to three to four times larger in flat to rolling terrain. Finally, some mixed-severity landscapes and long-interval replacement regimes, such as in the Pacific Northwest, Alaska, and the eastern U.S., might require assessment areas 10 to 50 times larger than the average patch size, depending on BpS and succession class diversity. That is, such landscapes often exhibit gap-phase replacement, where small openings in forests created by insects, diseases, or wind events promote regeneration in a constantly shifting mosaic (Bray 1956; Lertzman 1992; Agee 1993; Kneeshaw and Begeron 1998). Hypothetical guidelines for project landscape sizes (that is, appropriate analysis scales) relative to fire regimes can be found in table 2-4.

Table 2-4. Recommended analysis scales (in acres) for FRCC determination.

	Terrain	
Natural fire regime group	**Flat to rolling**	**Steep and dissected**
I – 0-35 years, low / mixed	500-5000	500-2500
II – 0-35 years, replacement	500-10,000	500-5000
III – 35-200 years, low / mixed	1000-20,000	1000-10,000
IV – 35-200 years, replacement	20,000-500,000	20,000-250,000
V – 200+ years, replacement	300,000-500,000	200,000-300,000
V – 200 + years, any severity	1000-20,000	1000-10,000

Although dominant fire regimes can provide some initial guidance, local expert opinion should also be used to evaluate the final boundaries of a proposed project landscape. If the area is too small, for example, a false picture of fire regimes and associated vegetation composition will result, leading to subsequent planning errors. If the area is too large, on the other hand, the ability to discern small changes in FRCC after future disturbances or management treatments will be lost. Also note that map classifications based on hydrologic units (http://datagateway.nrcs.usda.gov), the ECOMAP system (ECOMAP 1993; Winthers and others 2005), or similar units can often provide useful landscape delineations for FRCC assessments. (Note that appropriate analysis scales and classification systems for use with the FRCC Mapping Tool also will be discussed in Chapter 4). For example, hydrologic units ranging from subwatersheds to subbasins (or from land types to ecological subsections in ECOMAP), can be used to effectively aggregate BpS polygons into a contiguous landscape area. For the infrequent and rare replacement regimes, subwatershed and watershed units are likely too small to show the full array of succession classes in a given BpS, so subbasins might be more appropriate for analyzing FRCC. In contrast, subwatersheds may be adequate for analyzing biophysical settings dominated by fire regime groups I and II, because the BpS types those fire regimes often produce relatively small patch sizes. For delineations that occur as scattered small polygons or types with limited area due to biophysical constraints, a very large area or an adjustment of reference conditions (see Appendix B) may be necessary. Finally, note that the guidelines in table 2-4 are still largely hypothetical rather than empirically based. Local expert knowledge and future research could help users determine which analysis scales best document the historical range of BpS patch sizes in each fire regime group in a given locale.

Once the project landscape has been delineated, the area must then be subdivided according to dominant biophysical settings exhibiting distinct fire regime and unique structural characteristics. For FRCC purposes, we refer to these subdivisions as *strata*. In short, your landscape-level FRCC assessment will involve one or more strata, depending on the number of dominant vegetation types present. Occasionally, landscapes dominated by a single BpS may be stratified according to ecological condition, so that the user can assess FRCC for treated versus untreated areas separately. In addition, landscapes may be stratified by ownership delineations, thus allowing differences in FRCC to be described accordingly. But even these alternative subunits will usually be organized according to dominant biophysical settings.

To reiterate, scale-appropriate analysis will help reduce the potential for scale-induced estimation errors. That is, relatively small areas, such as subwatersheds, should be analyzed where small or patchy fires dominated historically (fire regimes I and II). Mid-scale reporting units, such as watersheds, should be analyzed where variable-sized mixed-severity fires (Fire Regime III) predominated. Conversely, fine- to mid-scale reporting units would be inappropriate for analyzing succession classes in terrain dominated by large replacement fires (regimes IV and V) because such fires can falsely appear to skew succession class composition relative to reference amounts. To avoid erroneous FRCC outcomes in regimes IV and V, therefore, analyses for these regimes should be conducted in relatively large-scale areas, such as subbasins or larger units.

Scale issues and landscape stratification summary

- FRCC can be defined at the stand level; however, because fire regimes operate at a landscape level, it is important to understand and evaluate FRCC at the landscape level before assessing at the stand level.
- Stand fire regimes data are used for modeling and assessing FRCC because stand data represent a lowest-common-denominator for calculating fire cycles at multiple scales.
- In FRCC methodology, a landscape is defined as the contiguous area within a delineation large enough to include the variation of the natural fire regimes.
- For designating project landscapes, the recommended analysis scales and a multidisciplinary approach should be used for determining appropriate landscape size for FRCC assessment.
- Landscapes are further divided into *strata*, each having a distinct fire regime and structure. In FRCC, these strata are referred to as *biophysical settings* (BpS).

FRCC science background: recent research

Research conducted by U.S. Forest Service Rocky Mountain Research Station personnel, by private contractors, and by the National Interagency Fuels Technology Team (NIFTT) has provided new insight into the scientific foundation of FRCC analysis. For example, ground-truthing of BpS model accuracy in the central Great Basin (Heyerdahl and others 2007; Swetnam 2006; Swetnam and Brown, in preparation) revealed that, while some FRCC Guidebook and LANDFIRE models were relatively accurate in terms of fire regimes traits and succession class composition, other models (particularly those biophysical settings with infrequent, mixed-severity and replacement regimes) occasionally contained substantial inaccuracies due either to high natural variation or a lack of empirical data. Research conducted in central Montana examining the spatial and compositional accuracy of LANDFIRE National models (Brown and Hann, in preparation) likewise found substantial variation during ground-truthing. Note, however, that relatively small inaccuracies in BpS models are usually acceptable because the FRCC algorithm allows for substantial variation in its departure formula and in the subsequent coarse FRCC classification (Brown, personal communication). However, the above-referenced research indicates that future research is needed to help document the historical range of variation rather than central tendency alone, and to possibly refine FRCC methodologies.

Although research has yielded no specific recommendations for changing and improving the FRCC methodology, research to date has produced the following implications for FRCC assessments and subsequent management planning based on FRCC results: 1) users should carefully evaluate all three sets of BpS models to date to identify which set is the most applicable for conducting a given FRCC assessment, 2) users of LANDFIRE data for field or GIS assessments should carefully evaluate the BpS compositional traits and the modeled spatial locations for potential applicability and overall accuracy, and 3) users should be aware of the latest research on BpS model accuracy (particularly with regard to HRV) so that users can calibrate and integrate new findings with local FRCC assessments. Such future research will presumably lead to improved FRCC methods and reference condition models to support FRCC users and natural resource planners.

Chapter 3: FRCC Standard Landscape Worksheet Method

This chapter provides step-by-step instructions for determining the natural fire regime, landscape FRCC, and stand FRCC of a project area using the Standard Landscape Worksheet Method. The directions under each field number are divided according to different user needs. The *Worksheet* directions (for use in conjunction with the Standard Landscape Worksheet, located in Appendix A) apply to examiners determining FRCC using local field data and performing manual calculations. The Field Form and Simple-7 Form instructions apply to examiners determining FRCC out in the field, or, for later use when entering data into the FRCC Software Application, which provides automatic FRCC calculations. The actual forms can be found in Appendix A. Finally, the *Software* directions apply specifically to those who want to enter the data directly into the FRCC Software Application. Where these are not specified, the instructions for a given step apply to all three media mentioned above.

> ***Note***: The FRCC Software Application User's Guide contains more detailed software instructions and can be accessed at www.frcc.gov. In addition, users should ensure they've got the latest version of the FRCC Software Application – also available at www.frcc.gov.

The Standard Landscape Worksheet Method provides the background understanding of the processes used to determine the natural fire regime, landscape FRCC, and stand FRCC and therefore provides the validation for the Estimation Technique (see the Estimation Technique for Determining Landscape and Stand FRCC section near the end of this chapter). For this reason, examiners should first become proficient with the detailed Standard Landscape Worksheet Method before employing the condensed Estimation Technique.

> ***Note***: Most fields are numbered sequentially; numbers that appear to have been "skipped" are retained for use by the computer program. In addition, field titles in bold on the Worksheet and Field Form (see Appendix A) and in blue in the software signify *required* data.

Project data (fields 1- 20)

Fields 1 to 20 are used to characterize the entire project area at the landscape level. Fields 1 to 4 uniquely identify the project area.

> ***Software note***: Since the database automatically opens with an example project entered, you will need to create a new project. Go to the menu bar at the top of form and select "Project," then select "New" from the drop-down menu to enter a new project. The Software User Guide at www.frcc.gov provides additional detailed instructions on using the FRCC Software Application.

Registration Code ID (field 1) – Required – Enter your 4-character code based on your agency affiliation. Visit the FRCC website at www.frcc.gov (under "Documents") for an updated list or contact the helpdesk at helpdesk@frcc.gov if your land management unit is not listed. We encourage non-federal agency users, such as state forestry departments, to create one Registration Code per management unit and then use different Project Codes for individual project areas.

Project Code (field 2) – Required – Enter a code used to identify the project area (you are not required to use all eight characters). Some examples of Project Codes follow:

TCRESTOR = Tenderfoot Creek Restoration
BurntFk = Burnt Fork Project
SCPF1 = Swan Creek Prescribed Fire, Unit 1
BoxCkDem = Box Creek Demonstration Project

You may want to use the same code you would use for the National Fire Plan Operations and Reporting System (NFPORS) or other non-federal reporting system.

Project Number (field 3) – Required – Assign and enter an integer value (for example, 1, 2, 3…) to serve as an identifier to distinguish this project area from others.

Project Characterization Date (field 4) – Required – Enter the date of examination that distinguishes these data from previous or subsequent characterizations. Enter as an 8-digit date in the MM/DD/YYYY format. For example, April 10, 2005 would be entered 04/10/2005.

If the same project area is being re-evaluated following management treatments, or after a substantial period of succession or unplanned disturbance such as wildland fire, keep the same Project Code and Project Number but change the Characterization Date. Strata within the project area that have *not* changed can be copied into the data entry program under the new date. Data for those strata that *have* changed must be entered as new data.

Examiner Code (field 5) – Required – For certified users, this is the user's email address (go to www.frcc.gov for details on becoming certified). Non-certified users can simply enter their names in this field.

Project Name (field 6) – Required – Enter the name of the project area (usually the area's major drainage or other prominent feature). You may want to cross-reference this with your NFPORS Project (or other non-federal reporting system project name).

Project Area Size (field 7) – Required – Enter the size of the project area in an integer value. The Project Area Size is the extent of the overall area where you will be applying the FRCC Standard Landscape Worksheet procedures. (See field 8 for measurement units.)

Project Area Units (field 8) – Required – Circle / select either acres or hectares as the measurement unit for the Project Area Size in field 7.

Recording a georeferenced project position (fields 10 to 15)

The following fields provide georeferencing for your project area. These fields are required and are important for such activities as re-photographing locations, placing the project into a geographic information system (GIS), or for coordination with the NFPORS database.

We recommend using a global positioning system (GPS) receiver to record latitude and longitude in decimal degrees rather than degrees, minutes, and seconds. When possible, select a central position in the project area with a panoramic view (fields 10 and 11) and for the current photo (field 16). Record the GPS coordinates to the sixth decimal place.

If you do not have a GPS receiver, estimate latitude and longitude using a USGS 1:24,000 topographic map.

Alternatively, you can simply enter "0" into fields 10, 11, and 15 then enter the Township-Range-Section coordinates in the comments field (field 20).

Latitude (field 10) – **Required –** Enter the latitude of the project area in decimal degrees to the sixth decimal place (for example, 45.951234).

Longitude (field 11) –**Required –** Enter the longitude of the project area in decimal degrees to the sixth decimal place (for example, 95.951234).

Datum (field 15) –Required – Enter / select the datum used. Datum is a model used to represent map coordinates on the Earth's surface. If you are unsure, contact your local GIS coordinator to see which datum is preferred. If you are not using GPS coordinates, leave this field blank.

You may want to use the same georeferenced position used in your NFPORS reporting system (or other non-federal reporting system). In NFPORS, this is the center point of the treatment area.

Documenting your project area with current and reference condition (historical) photos *(fields 16 to 19)*

Digital photographs and scans are useful means by which to document your project area as they provide a unique opportunity to visually assess the project area or vegetation class in a database format for local, regional, and national use. Document the project area with a current landscape-view or aerial view photograph. If possible, scan a reference condition picture of the project area taken from a similar viewpoint or a picture of a landscape with similar biophysical settings. Photos can be compared to determine important changes after project area treatment implementation or an unplanned fire or other disturbance. In addition, previously established treatment areas can be located by orienting landmarks in the photos to visual cues in the field. Photos also serve as excellent communication tools for describing project rationale to the public and to fire and fuels personnel. Potentially the most important use of these photos lies in the development of a photo series for use in evaluating a treatment's effectiveness.

See the Software User Guide (www.frcc.gov) for detailed instructions on incorporating digital photos into your project database.

Current Photo (field 16) – Not Required

Worksheet or Field Form: Enter a name and location for the photo (a pathway on your computer or other location indicating where the photo is stored).

See the Software User Guide (www.frcc.gov) for detailed instructions on incorporating digital photos into your project database.

Current Photo Date (field 17) – Not Required **–** Enter the date the current photo was taken as an 8-digit date in the MM/DD/YYYY format.

Reference Condition Photo (field 18) – Not Required **–**

Worksheet or Field Form: Enter a name and location for the photo (a pathway on your computer or other location indicating where the photo is stored).

See the Software User Guide (www.frcc.gov) for detailed instructions on incorporating digital photos into your project database.

Reference Condition Photo Date (field 19) – Not Required **–** Enter the date the reference condition photo was taken as an 8-digit date in the MM/DD/YYYY format.

Entering comments about the project area *(field20)*

The Comments field is provided for the field examiner to record information about the project area that cannot be recorded elsewhere on the form. For example, you can record ancillary information about ecological conditions, dates of wildland fire or fire use occurrence, general location information, historical information, or other attributes as desired.

Comments (field 20) – Not Required **–** Briefly enter any relevant comments about the project area that might be helpful to managers and future assessors. To save space in this data field, economize with abbreviations as necessary.

Strata data: general information, biophysical settings, natural and current fire regimes (fields 21- 60)

As discussed in Chapter 2, the project landscape is stratified according to:

- differences in biophysical settings (BpS)
- differences in fire regime groups
- BpS life forms (table 3-1),
- treatment versus non-treatment units, or
- other biological or management criteria

Delineate as many strata as you deem necessary, keeping in mind that the individual strata, when combined, must total 100 percent of the project area.

If you need to conduct an assessment in a short amount of time, we suggest you do not designate any strata comprising less than 20 percent of the project landscape - unless such strata have very important management implications. Stratifying by only the dominant BpS types or other criteria will usually result in just 2 to 3 strata.

> **→Important - For multiple strata:**
>
> *Worksheet:* copy an ***additional*** Stratum Data Page (p. 2 of the FRCC Standard Landscape Worksheet) to complete fields 21 to 60 for ***each*** of your strata.
>
> *Field Form:* use the additional Stratum Data sections provided to complete fields 21 to 75 for ***each*** of your stratum.
>
> *Software:* The cursor will automatically tab to the Stratum Data block below the Project Data block. You will need to complete this and the Succession Class Data block for ***each*** of your stratum. Create blank Stratum and Succession Class blocks for each additional stratum by clicking on the "New" (New Stratum) button located to the right of the Stratum Number field at the top of the Stratum Data block.

Stratum Number (field 21) – **Required** –

Worksheet or Field Form: Number your strata on each of your stratum worksheets. Number each stratum incrementally, starting with 1 (1, 2, 3, etc.)

Software: The strata numbers will be automatically assigned by the program.

Stratum Code (field 22) – **Required** – Enter a logical code that may be used to crosswalk the stratum to your reporting system (for example, perhaps you can use the same code as the "Treatment Unit Name" data field in NFPORS).

Stratum Name (field 23) – Not Required – Enter a logical descriptive name for the stratum, for general identification purposes (for example, "Ponderosa Pine").

Stratum Characterization Date (field 24) – **Required** – Enter the date the stratum data were collected in the MM/DD/YYYY format (the software program will default to the date entered in the Project Data block but can be changed if needed). This date can be different from the Project Characterization Date (because of a different date of sampling) but should be in the same *general* time period to avoid confusing future evaluators.

Identifying life form and associated biophysical setting *(BpS) (fields 25 and 26)*

To correctly identify the life form and associated BpS (fields 25 and 26), first review the following terms:

Canopy cover – The percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of plant foliage. Small openings within the canopy are included (SRM 1989, NRCS 1997).

> ***Note****:* Users with foliar cover data should covert it to canopy cover using the best available data and local expertise. This conversion will reflect the species, vigor, and age of the vegetation.

Natural fire regime – A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human intervention, but can include the influence of aboriginal fire use (Agee 1993; Brown 1995)

Forest – Conifer or broadleaf trees with an average upper layer height of greater than 5 meters (approx.17 ft) and with canopy cover of at least 25 percent during the late successional stage.

Woodland – Conifer or broadleaf trees with an average upper layer height of greater than 5 meters and with canopy cover ranging from 10 to 25 percent during the late seral stage of development.

Shrubland – Mature trees have a height of greater than 5 meters (approx. 17 ft) and shrub cover is at least 10 percent.

Grassland – None of the above conditions for forest, woodland, or shrubland met, and graminoid / herb cover is at least 5 percent.

You'll next be asked to identify the life form for the biophysical setting you will later identify in field 26. Note that **the most common error in determining potential natural life form** (for example, forest, woodland, or shrubland) **results from the selection of a life form simply because that is what currently exists on that landscape**. For this reason, be sure to verify your initial selection by reviewing reference condition photos (landscape or aerial view). Additional note: if most or all of the current life form is of one size class that began development since Euro-American settlement, the area was most likely *not* characterized by that life form historically.

Now use the following key to identify the life form for the biophysical setting you will later identify in field 26.

Key to Potential Natural Life Forms

Note: "Life forms," as used in this key, refer to the physiognomic vegetation formations of the Federal Geographic Data Committee (FGDC) National Vegetation Classification (FGDC 1997).

1a. Canopy cover of trees ≥ 10% under the historical disturbance regime: **Go to 2**

1b. Canopy cover of trees < 10% under the historical disturbance regime: **Go to 3**

2a. Mature (late successional) height of trees ≥ 5 meters (16.5 ft) and canopy cover ≥ 25%:

Forest

2b. Mature (late successional) height of trees ≥ 5 meters (16.5 ft) and canopy cover ≥ 10% and ≤ 25%:

Woodland

Note: "Woodland" is an unofficial subdivision of Forest and is not recognized in all vegetation classifications; however, data can be easily collapsed into the Forest group, if necessary.

2c. Mature (late successional) height of trees <5 meters: **Go to 4**

3a. Canopy cover of shrubs ≥ 10% (or foliar cover ≥ 5%): **Go to 4**

3b. Canopy cover of shrubs < 10% (or foliar cover < 5%): **Go to 5**

4a. Potential canopy cover of trees ≥ 10% (not currently present due to altering of the historical disturbance regime):

Shrubland w/ Trees

4b. Potential canopy cover of trees < 10%, even with an altered disturbance regime:

Shrubland

5a. Canopy cover of graminoids / herbs ≥ 5%: **Go to 6**

5b. Canopy cover of graminoids / herbs < 5%: **Barren**

6a. Non-forest; upper canopy life form primarily grasses: **Go to 7**

6b. Non-forest; upper canopy life form primarily forbs and / or sedges / rushes:

Herbaceous Meadows, Non-Forest

Wetlands, Tundra

7a. Canopy cover of trees ≥ 10% (not currently present due to altering of the historical disturbance regime):

Grassland w/ Trees

7b. Potential canopy cover of trees < 10%, even with an altered disturbance regime:

Go to 8

8a. Potential canopy cover of shrubs ≥ 10% (or foliar cover ≥ 5%) (not currently present due to altering of the historical disturbance regime):

Grassland w/

Shrubs

8b. Potential canopy cover of shrubs < 10% (or foliar cover < 5%) even with an altered disturbance regime:

Grassland

Note: Be aware that what may appear to be forest or woodland may actually be a natural shrubland or grassland BpS that has been influenced by tree or shrub. Use the following interpretations:

Tree encroachment potential in shrubland or grassland:

Shrubland or grassland is the natural cover associated with the historical disturbance regime and:

1. Trees are currently present in the stratum or
2. Trees are not currently present, but there is potential and an available seed source (typically within a mile).

Shrub encroachment potential in grassland:

Grassland is the natural cover associated with the historical disturbance regime and:

1. Shrubs are currently present on the stratum land unit or
2. Shrubs are not currently present, but there is potential and an available seed source (typically within a mile).

→***Important note:***

Worksheet and Field Form: All subsequent default fields (marked as "def" on the form) will later be automatically populated by the software with reference values correlating to your BpS selection for field 26 below; if desired, however, you can also complete these fields on the worksheet or field form. In these cases, simply follow the "Worksheet" directions.

Software: All subsequent default fields will later be automatically populated with reference values correlating to your BpS selection in field 26 below.

Stratum BpS Life Form (field 25) – Required – This field represents the dominant life form associated with the BpS you will later identify for field 26.

Worksheet or Field Form: Enter the 2-character code (from table 3-1 below) for the life form identified above in the *Key to Potential Natural Life Forms.*

Software: This field will be automatically populated according to your selection for field 26.

Table 3-1. BpS life form codes.

Code	BpS life form
AQ	Aquatic – lake, pond, bog, river
NV	Non-vegetated – bare soil, rock, dunes, scree, talus
CF	Coniferous upland forest – pine, spruce, hemlock
CW	Coniferous wetland or riparian forest – spruce, larch
BF	Broadleaf upland forest – oak, beech, birch
BW	Broadleaf wetland or riparian forest – tupelo, cypress
SA	Shrub-dominated alpine – willow
SU	Shrub-dominated upland – sagebrush, bitterbrush
SW	Shrub-dominated wetland or riparian – willow
HA	Herbaceous-dominated alpine – dry
HU	Herbaceous-dominated upland – grasslands, bunchgrass
HW	Herbaceous-dominated wetland or riparian – ferns
ML	Moss- or lichen-dominated upland or wetland
WD	Woodland
OT	Other BpS vegetation life form

Stratum BpS Code (field 26) – **Required** – Once you have determined and entered the BpS life form for the stratum, the next step is to identify the applicable BpS. We recommend using the LANDFIRE National model descriptions whenever possible, but note that the National modeling phase will continue through 2009. As of this writing, LANDFIRE National model descriptions are available for all western mapping zones (see http://www.landfire.gov/national_veg_models_op1.php to determine if your project area falls within one of these western zones). The model descriptions for the eastern U.S., Alaska, and Hawaii will be completed on an incremental basis. Users can check the LANDFIRE website's model delivery page (http://www.landfire.gov/national_veg_models_op1.php) to see if the desired descriptions have been posted or contact the helpdesk at helpdesk@frcc.gov for information.

If the LANDFIRE National model descriptions for your project area have not yet been posted, you can access the coarser-scale LANDFIRE Rapid Assessment (RA) models (available for the conterminous U.S. only) on the LANDFIRE website's RA model description delivery page at http://www.landfire.gov/models_EW.php. And yet a third option is the original FRCC Guidebook models and descriptions (available at www.frcc.gov under the Resources tab). Although these provide the coarsest-scale data of the three sets, they can be used either to assess FRCC for new project landscapes or to assess landscapes previously analyzed with those models. (In addition to the model descriptions, BpS diagnostic keys for the FRCC Guidebook models are available at www.frcc.gov (under Resources). Note, however, that such keys do not exist for the more numerous LANDFIRE models.)

> ***Note***: Do not try to use more than one set of BpS models for a given FRCC assessment because the applicable scales and degrees of refinement vary greatly between the three sets of models. For example, the relatively coarse-scale models initially developed for the FRCC Guidebook were subsequently subdivided and refined during the two LANDFIRE modeling phases.

First, obtain the BpS model descriptions and associated reference condition tables for the mapping zone containing your project landscape. Then, identify which of the many listed biophysical settings represent the strata in your particular project landscape (ensuring that the geographic area, site description, species, and disturbance regime are applicable). These description documents should be read thoroughly and used often throughout the FRCC assessment process to ensure that you haven't identified the wrong BpS. ***The most common error in determining FRCC is selecting the wrong BpS.***

Worksheet or Field Form: Enter the appropriate BpS code from the applicable reference condition summary table (also obtainable from each description document). Note that you can also enter your own custom designed code for any locally generated BpS data.*

Software: The software contains three sets of BpS codes to date: 1) the LANDFIRE National models for the western U.S. (again, check www.landfire.gov for additional models posted incrementally), 2) the LANDFIRE Rapid Assessment models for the conterminous U.S., and 3) the FRCC Guidebook models for the conterminous U.S. and

Alaska. Simply select the applicable BpS code from the drop-down menu (or enter your own code for any locally generated BpS data*).

→***Important note:***

Users may elect to replace the default model data with locally generated data, using the following protocol. First, enter "XXXX" in field 26 and return to field 25 to manually enter the appropriate life form code. Then, complete the following steps to generate the new local data set:

Adjust reference conditions (the seven reference conditions include up to five succession classes, plus fire frequency and severity) **ONLY** after meeting the following criteria:

1) Document which suitable reason from Appendix B justifies changing the reference conditions from the default.

2) Document that the reference condition has been adjusted in combination with the 6 other reference conditions through use of the Vegetation Dynamics Development Tool (VDDT) (Beukema and others 2003a) or similar non-spatial model or through a companion spatial model such as Tool for Exploratory Landscape Analysis (TELSA), Landscape Succession Model (LANDSUM), or other similar spatial model. This process avoids an inconsistent combination of the 7 reference conditions. Note that the above-mentioned spatial models are available at www.essa.com.

3) Document the local expert or team making the adjustment and the associated literature and field reconnaissance that was used in support.

This documentation will support the use of your refined expert estimate and more localized literature and field reconnaissance.

Stratum BpS indicator species *(fields 27 to 30)*

An indicator species is usually the most dominant species found in a BpS under reference (historical) conditions. Uncharacteristic disturbance or succession can reduce or eliminate these species. To clarify, these species are not necessarily what is found *currently* in the stratum; indicator species are based on reference conditions (see the BpS description documents).

Worksheet or Field Form: For fields 27-30, write at least one and up to four species that are indicative of the type of site conditions and natural disturbance regimes typical of the BpS. We recommend that you later check against the NRCS plant species code (at www.frcc.gov under NIFTT Resources) and, if different, change for consistency in communicating data.

Software: For fields 27-30, select (from the drop-down menus) at least one and up to four species (taken from the NRCS plant list) that are indicative of the type of site conditions and natural disturbance regimes typical of the BpS. Note the "Species" button to the left of the indicator species boxes (fields 27 – 30). This feature allows you to query the NRCS list of plant species. Further details on this feature can be found in the FRCC Software Application – go to www.frcc.gov and select FRCC software in the menu. You will then be re-routed to www.fire.org, where all NIFTT tools are housed.

Stratum Indicator Species 1 (field 27) – **Required** – See directions above.

Stratum Indicator Species 2 (field 28) – Not Required – See directions above.

Stratum Indicator Species 3 (field 29) – Not Required – See directions above.

Stratum Indicator Species 4 (field 30) – Not Required – See directions above.

Stratum Local BpS Code (field 31) – Not Required – Enter up to a 10-character alpha-numeric code for a local BpS if applicable (for example land type, habitat type, plant association, range site, ecological land unit, potential vegetation type, or group).

Stratum Landform (field 32) – Required – Enter / select a coarse-scale Landform Code from table 3-2 below (or from the software drop-down menu).

Table 3-2. Landform codes.

Code	Landform
GMF	Glaciated mountains-foothills
NMF	Non-glaciated mountains-foothills
BRK	Breaklands, river breaks, badlands
PLA	Plains, rolling plains, plains with breaks
VAL	Valleys, swales, draws
HIL	Hills, low ridges, benches

Stratum Average Slope Class (field 34) – Required – Enter / select a Slope Class from table 3-3 below (or from the software drop-down menu):

Table 3-3. Slope percent class codes.

Code	Slope percent
GENTL	0-10
MOD	11-30
STEEP	31-50
VSTEEP	> 50

Stratum Insolation (Aspect) Class (field 36) – Required – Insolation is a relative classification of the amount of sun heating reception. This is typically related to the aspect of slopes and the influences of warm or cold airflow. Enter / select an Insolation Class from table 3-4 below (or from the software drop-down menu):

Table 3-4. Insolation class codes.

Code	Insolation
LOW	NW, N, NE, E aspect or flat if cold air drainage
MOD	Flat ($\leq$ 10 percent slope)
HIGH	W, SW, S, SE aspect or warm air upflow from adjacent valley

Stratum Low Elevation (field 38) – Required – Enter an elevation that represents the *typical* lower elevation of the stratum (note: this is not the statistical minimum). If the elevation does not change within the stratum, enter the same elevation for low and high. (See field 40 for measurement units.)

Stratum High Elevation (field 39) – Required – Enter an elevation that represents the *typical* upper elevation of the stratum (note: this is not the statistical maximum). If the elevation does not change within the stratum, enter the same elevation for low and high. (See field 40 for measurement units.)

Stratum Elevation Units (field 40) – Required – Circle / select either feet or meters as the elevation measurement unit for fields 38 and 39.

Stratum Composition (field 41) – Required – Estimate the percentage of the total project area that falls within this stratum (for example, enter 20 for 20 percent; do not use a decimal). The sum of all strata for the project area must total 100 percent.

Recording a georeferenced position *(fields 43-50)*

The following fields provide georeferencing for your various strata. These fields are required and are important for re-photographing locations, for placing the stratum into a geographic information system (GIS), and for cross-walking to the NFPORS database.

We recommend using a global positioning system (GPS) receiver to record latitude and longitude in decimal degrees rather than degrees, minutes, and seconds. Your selection for location of the stratum position is flexible. Select a point that is generally central to the stratum area or a point that provides a good visual perspective of the stratum. Select the location from which the stratum photo (field 49) is taken so that the photo can be repeated at a later date for monitoring purposes. Record the GPS coordinates to the sixth decimal place.

If you do not have a GPS, you can determine latitude and longitude using a USGS 1:24,000 quad map.

If you cannot determine latitude and longitude, enter "0" into the fields and enter a legal location description in the comments (field 60).

Stratum Latitude (field 43) – Required – Enter the latitude of the stratum center in decimal degrees to the sixth decimal place (for example, 45.951234).

Stratum Longitude (field 44) – Required – Enter the longitude of the stratum center in decimal degrees to the sixth decimal place (for example, 95.951234).

Datum (field 48) – Required – Enter / select the datum used. Datum is a model used to represent map coordinates on the Earth's surface. If you are unsure of which to use, contact your local GIS coordinator to see which datum is preferred. If you are not using a GPS, leave this field as is.

Current Stratum Photo (field 49) – Not Required **–**

Worksheet or Field Form: Enter a name and location for the photo (a pathway on your computer or other location indicating where the photo will be filed for future reference). See the Software User Guide under the Software tab at www.frcc.gov for detailed instructions on incorporating digital photos into your project database.

Current Stratum Photo Date (field 50) – Not Required **–** Enter the date the stratum photo was taken as an 8-digit date in the MM/DD/YYYY format.

***Fire regimes data** (fields 51-54)*

Fields 51 through 54 ask you for the *central tendency* or mean of the reference condition and current fire frequencies and severities. It is important to note that an exact average is not required; rather, your estimate of the central tendency is assumed to have plus or minus 33 percent variation (refer to the Reference Condition Modeling section in Chapter 2 for an explanation of using central tendency for FRCC purposes).

See instructions for field 26 above to review information on accessing the BpS descriptions.

Stratum Reference Condition Fire Frequency (field 51) – Required – This is the mean fire interval (MFI) for the Reference Condition Fire Frequency. MFI is defined as the average number of years between fires in representative stands (defined as "cluster scale" by Arno and Peterson 1983) for each BpS stratum. Also note that the term "representative" ideally refers to an average MFI (grand mean) from multiple sites sampled during field research cited by the BpS modelers.

Worksheet: Obtain the representative MFI from the reference condition summary tables*, from regional values (such as local studies), or from your own local estimates. For the latter approach, estimate a representative stand-level MFI as follows: Divide the number of years in the fire period (*not* the total tree age) by the number of fires minus one (N-1). For example, if six fires occurred between 1800 and 1860, the MFI formula would be:

$$(1860 - 1800) / (6 - 1) = 12 \text{ MFI}$$

Finally, compute a grand mean by averaging all of the stand MFI data obtained for that BpS.

> ***Note***: A few of the LANDFIRE National biophysical settings, such as *Inter-Mountain Basins Mat Saltbrush Shrubland*, are considered to be non-fire ecosystems (hereafter referred to as "non-fire strata"). Consequently no fire regimes information appears in those model descriptions. In such cases, simply enter "9999" for the reference fire frequency to serve as a quasi-infinity value.

Software or Field Form: The data entry program will automatically populate this field with values from the reference condition summary tables; again, you may replace this default value with local data, if desired.

→Note regarding using local data: Rather than conducting intensive fire history sampling, we encourage users to conduct a general field reconnaissance (see suggested methods in field 52 below), or, use literature searches and the local "expert opinion" approach.

Estimating current fire frequency *(MFI) (field 52)*

In field 52 below, you'll be asked to estimate a representative current fire frequency for each stratum by analyzing post-settlement fire activity. Tally all spreading fires caused by lightning and humans (including prescribed fires) regardless of whether the severity pattern was natural. (Note that Current Fire Severity pattern will be addressed in field 54). In other words, the goal is to analyze fires that substantially influenced the vegetation.

Whether to include comparatively small suppressed fires (such as size classes "B" and "C") is up to the user. Small fires can certainly be important ecologically, especially if such fires occurred in the natural fire regime or if the stratum is limited in extent. In general, however, you probably wouldn't want to include most "Class A" spot fires that were readily suppressed.

Following are three potential methods for estimating Current Fire Frequency, the first using fire atlas records and the others using field examinations.

Below is a method for estimating Current Fire Frequency using **fire atlas records**.

> Step 1 - For the reference condition period, estimate the mean annual burned acres by dividing the BpS acreage by its associated fire frequency (MFI).
>
> *EXAMPLE*: A 10,000 acre stratum with a 10-year MFI yields an average of 1000 burned acres per year (10,000 / 10 = 1000).
>
> Step 2 - Estimate mean annual burned acres for the current period by analyzing fire atlas records.
>
> *EXAMPLE:* Fire records indicate that fires have burned a total of 3,500 acres in the stratum since 1935. Therefore, modern-day fires have burned an average of 50 acres per year (3,500 acres / 70 years = 50).
>
> Step 3 – Estimate Current Fire Frequency by comparing the results.
>
> The current period value computes to a twenty-fold reduction in natural fire occurrence (1000 reference period acres / 50 current period acres = 20). So, multiply the reference period MFI by a conversion factor of twenty to determine current fire frequency, then enter the result in field 52.
>
> *EXAMPLE:* 10-yr reference MFI x 20 = 200-yr current MFI.

Next are two methods for estimating Current Fire Frequency (MFI) based on general **field examinations** (for *forest* biophysical settings only). Remember, the goal is to characterize "representative" fire frequency for the stratum, by estimating how often a typical site has burned during the post-settlement era.

Method A: Examine fire-scarred stumps with known logging dates. If no stumps are available, you may have to sample some live trees (for examples, see Arno and Sneck 1977 and Barrett and Arno 1988). Estimate the stand MFI by dividing the number of years in the fire period by the number of fire intervals (total scars minus 1) (see fig. 3-1 below). Then compute a grand mean by averaging all of the stand MFI data obtained for that BpS.

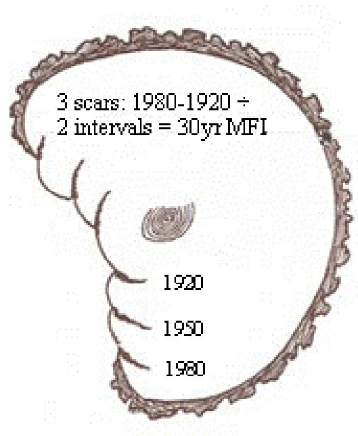


Figure 3-1. Estimating current fire frequency (MFI) from stump with multiple fire scars (*after*: Barrett and Arno 1988).

Method B: (Alternative method) If it is not possible to estimate a representative MFI, use the number of years since the last fire to represent Current Fire Frequency (see fig. 3-2 below). For example, this value can be estimated by: 1) examining stumps with known logging dates, 2) by using an increment borer to estimate the date of the last fire scar on live trees, or 3) by estimating post-fire regeneration dates for even-aged stands (such as in lodgepole pine [*Pinus contorta*] forests). Then compute a grand mean by averaging all of the years-since-last-fire data obtained for that BpS.

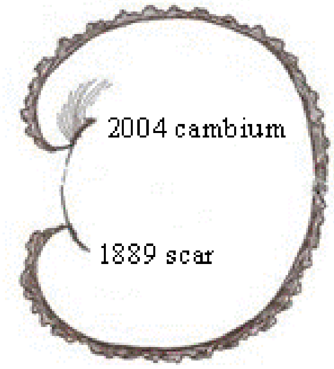


Figure 3-2. Estimating the number of years since the last fire (*after*: Barrett and Arno 1988).

Stratum Current Fire Frequency (field 52) – Required – Estimate Current Fire Frequency (MFI) using one of the above methods. Note: If there is no evidence of fires occurring during the post-settlement era, we recommend entering 100 years as a default value. For any non-fire strata, simply re-enter the "9999" default value as mentioned above.

Stratum Reference Condition Fire Severity (field 53) – Required – This metric refers to the proportion of stand replacement (defined as 75 to 100 percent upper-layer life form replacement) during 90^{th} percentile burning conditions. For example if the stratum is comprised of scattered large conifers with a grass understory, estimate the proportion of replacement within the conifer component, not the grass layer. Use the default values (which are estimates derived from simulation modeling) from the reference condition summary tables*, or develop your own estimate after conducting similar modeling. Also note that this estimate refers only to vegetation that actually burned, not to any unburned areas within the gross fire perimeter.

> ***Note***: For any non-fire strata, enter "0" as the default value.

Stratum Current Fire Severity (field 54) – Required – Estimate current stand replacement potential for a representative site within the stratum based on modern fire records and/or local expert opinion. Enter the percentage as an integer, not a decimal. If your analysis suggests more than a 10 percent departure from the reference severity, you may select a midpoint value from the following list. Again, base your evaluation only on the burned vegetation (or vegetation expected to burn during future fires) and exclude unburned areas within the gross fire perimeter.

0-5 percent (upper canopy layer replacement)	central tendency = **3** percent
6-15 percent (upper canopy layer replacement)	central tendency = **10** percent
16-25 percent (upper canopy layer replacement)	central tendency = **20** percent
26-55 percent (upper canopy layer replacement)	central tendency = **40** percent
56-85 percent (upper canopy layer replacement)	central tendency = **70** percent
86-100 percent (upper canopy layer replacement)	central tendency = **90** percent

> ***Note:*** If your analysis suggests that fire severity potential hasn't changed substantially during the current period, simply re-enter the reference value. For example, in most stand-replacement regimes, fire severity potential has not changed since the historical reference period. Similarly, for any non-fire strata, enter "0" as the default value.

Stratum metadata *(fields 55-57)*

Stratum Reference Condition S-Class Percent Composition Source (field 55) – Required –

Worksheet: From table 3-5 below, enter the 1-character code representing the source from which you acquired the data that are to be entered below in fields 62 – 72 (Reference Condition Stratum S-Class Composition).

Software or Field Form: The data entry program will automatically populate this field with the source code of "D," indicating data acquired from the reference condition summary tables; however, if you choose to replace the default values in fields 62-72 with more accurate local values, select the appropriate code from the drop-down menu (representing the source from which you acquired the data to be entered in fields 62 – 72).

The source selections are ordered from least to most rigorous regarding validity of the values obtained.

Table 3-5. Reference condition S-class composition source codes.

Code	Source
N	Non-local expert estimate
D	Reference conditions determined through literature review and modeling workshops
R	Regional / state default values from literature review and modeling workshops
L	Local expert estimate
T	Interdisciplinary team (IDT) consensus with local expert
M	Local expert estimate with literature review and modeling
B	IDT consensus from literature review and modeling workshops with local expert
F	Published local study with literature review and modeling workshops

Stratum Current S-Class Percent Composition Source (field 56) – Required –

Worksheet: From table 3-6 below, enter the 1-character code representing the source from which you acquired the data that are to be entered below in field 73 (Current Stratum S-Class Composition).

Software or Field Form: The data entry program will automatically populate this field with the source code of "R," indicating data acquired from a walk through and visual estimate as this is the recommended method; however, if you choose to replace the default values in field 73 with a more accurate local value, select the appropriate code from the drop-down menu (representing the source from which you acquired the data to be entered in field 73).

The source selections are ordered from least to most rigorous regarding validity of the values obtained.

Table 3-6. Current S-Class composition source codes.

Code	Source
V	Visual estimate
R	Walk through with visual estimate
M	Mapped summary

Stratum Reference Condition Fire Frequency and Native American Burning (field 57) – Required –

Worksheet: From table 3-7 below, enter the 1-character code representing whether Native American fire use influenced the reference conditions above for field 51.

Software or Field Form: The data entry program will automatically populate this field with the code of "C," indicating use of default reference condition value for field 51 (which includes influence of Native American burning); however, you may replace this default value with a more accurate code from the drop-down menu (representing how you addressed the issue of inclusion of Native American burning in the reference condition fire frequency above in field 51).

Refer to Barrett and Arno (1982) for a discussion of ecological implications.

Table 3-7. Inclusion of Native American burning influence in reference condition fire frequency value for field 51.

Code	Inclusion of Native American burning influence
C	Used default reference condition summary tables
A	Substantial Native American burning influence included
D	Substantial Native American burning influence, but not included
W	Native American burning considered but not different than without
N	Native American burning influence not considered

S-Class breakpoints *(fields 58-59)*

Later, in fields 62-75, you'll be asked to evaluate the structure and composition of each S-Class in the BpS stratum. Note again that the characteristic succession classes in the standard 5-box model are:

S-Class A , early-seral, post-replacement (previously also known as Class AESP in FRCC Guidebook Version 1.2.0)
S-Class B (previously BMSC), which typically represents a mid-seral, closed canopy condition
S-Class C (previously CMSO), which often represents mid-seral, open canopy stands
S-Class D (previously DLSO), which usually refers to late-seral, open canopy stands
S-Class E (previously ELSC), which often represents the late-seral, closed canopy condition

Be aware, however, that not all BpS models conform to this standard 5-box model, so users should always consult the associated BpS model description documents before conducting FRCC field assessments.

> ***Note***: Table 3-15 at the end of this document provides addition information describing succession classes.

Fields 58-59 below ask you to identify the canopy closure percentage breakpoints between *open* and *closed* canopies if canopy closure was included.

Stratum B to C S-Class Breakpoint (field 58) – Not Required **–**

Worksheet or Field Form: Enter the canopy closure breakpoint percentage for differentiating between succession classes B (mid-seral, *closed* canopy) and C (mid-seral, *open* canopy). Use the following default values: **35 percent** canopy closure for forests and woodlands and **15 percent** for shrublands and herblands. Or, if you have a more accurate local value, enter this. Enter the percentage as an integer, not a decimal.

Software : The program will automatically populate this field with the default value; however, if you have a more accurate local value, replace the default value with this. Enter the percentage as an integer, not a decimal.

> ***Note:*** *If a value in addition to canopy closure is used to determine the breakpoint*, leave the above default values but, in the "Comments" field (field 60), note the additional variable used.

Stratum D to E S-Class Breakpoint (field 59) – Not Required **–**

Worksheet: Enter the canopy closure breakpoint percentage for differentiating between succession classes D (late-seral, *open* canopy) and E (late-seral, *closed* canopy). Use the following default values: **35 percent** canopy closure for forest, woodland, and herbland, and **15 percent** for shrubland. Or, if you have a more accurate local value, enter this. Enter the percentage as an integer, not a decimal. Remember, these values are based on reference conditions so you may be able to extract this information from the description document for your BpS.

Software or Field Form: The program will automatically populate this field with the default value; however, if you have a more accurate local value, replace the default value with this. Enter the percentage as an integer, not a decimal.

> ***Note:*** *If a value in addition to canopy closure is used to determine the breakpoint*, leave the above default values but, in the "Comments" field (field 60), note the additional variable used.

Stratum Comments (field 60) – Not Required **–** Briefly enter comments regarding the stratum. For example, describe situations in which you used the "other" code (OT) or could not complete a particular field. To save space in this data field, economize with abbreviations as necessary.

Strata data: succession class composition fields (fields 62- 75)

Use the BpS description documents, reference condition summary tables, regional descriptions (if available), or develop custom local descriptions of the characteristic (using reference conditions from the reference condition summary tables) and uncharacteristic succession classes. Again, note that table 3-15 at the end of this document provides addition information describing succession classes.

Reminder:

For fields 62-75, you will again need to complete these fields for *each* of your strata on additional copies of the Stratum Data page (p. 2 of the Standard Landscape Worksheet – see Appendix A). Field Form users: use the additional strata sections provided (again, see Appendix A). Software users: enter into a new S-Class block for each Stratum you add.

> ***Note*:** As mentioned above, for many biophysical settings, the characteristic succession classes A through E do not always follow the general descriptions given in table 3-15. In many grasslands, for example, there might be only three classes: 1) immediate post disturbance (S-Class A), 2) mature-open (S-Class B), and 3) mature-closed (S-Class C). Users therefore must always read the BpS description documents or reference condition summary tables to determine how each class is defined.

Stratum S-Class Code (field 62) – Required – First, determine which of the five *characteristic* succession classes exist within the stratum, and for fields 63-75, leave blank any succession classes not occurring in the stratum.

Worksheet or Field Form: Then, beneath the characteristic classes, write the 4-character code (from table 3-15) for any *uncharacteristic* succession classes occurring in the stratum.

Software: Then, to enter any *uncharacteristic* succession classes, click on the "New" button (to the left of the characteristic classes) and a row for an uncharacteristic class will appear below the characteristic classes. Click in the "Code" cell to select from the drop-down menu the applicable uncharacteristic S-Class. Simply repeat the procedure for any additional existing uncharacteristic classes (note: you may need to scroll down to view these).

Note: For fields 63 through 70, answers should be based on current conditions but should reflect the BpS reference descriptions for characteristic types. Follow these steps:

1) Read the BpS description document and study the descriptions of each S-Class.
2) Locate these succession classes in your landscape.
3) Describe these succession classes in fields 63 through 70.

S-Class Upper Layer Life Form (field 63) – Required (for each S-Class in the BpS) **–** Work sequentially through table 3-8 below (or software drop-down menu) until you find the determination criteria matching the stratum's upper layer life form; enter the 4-character code.

Table 3-8. Upper layer life form codes.

Code	Life form	Upper layer determination criteria
CONT	Coniferous trees	≥ 10 percent canopy cover
BRDT	Broadleaf trees	≥ 10 percent canopy cover
SHRB	Shrubs	≥ 5 percent line intercept cover or ≥10 percent canopy cover
HERB	Herbaceous (graminoids, forbs, and ferns)	≥ 15 percent ground cover
MOSS	Moss or lichens	≥ 5 percent ground cover
NVEG	Non-vegetated	< 5 percent any vegetation cover
NNNN	Does not fit any category	

S-Class Upper Layer Size Class (field 64) – Required (for each S-Class in the BpS) **–** From table 3-9 below (or software drop-down menu), select / enter the 4-character size class code for the stratum's dominant upper layer life form (from field 63).

Table 3-9. Upper layer life form size class codes.

Size class code	Dimensions
Coniferous and Broadleaf Trees	
SEED	Seedling - Trees that are < 4.5 feet (1.37 meters) tall.
SAPL	Sapling - Trees that are ≥ 4.5 feet (1.37 meters) tall and < 5.0 inches (13 cm) Diameter Breast Height (DBH).
POLE	Pole - Trees that are ≥ 5 inches (13 cm) DBH and < 9 inches (23 cm) DBH.
MEDM	Medium - Trees that are ≥ 9 inches (23 cm) DBH and < 21 inches (53 cm) DBH.
LARG	Large - Trees that are ≥ 21 inches (53 cm) DBH and < 33 inches (83 cm) DBH.
VLAR	Very large - Trees that are ≥ 33 inches (83 cm) DBH.
Shrubs	
LOWS	Low - Shrubs that are ≤ 3 feet (1 meter) tall.
MEDS	Medium - Shrubs that are > 3 feet (1 meter) tall and < 6.5 feet (2 meters) tall.
TALS	Tall - Shrubs that are ≤ 6.5 feet (2 meters) tall.
Herbaceous	
LOWH	Low - Herbaceous ≤ 2 feet (0.6 meters) tall.
TALH	Tall - Herbaceous > 2 feet (0.6 meters) tall.
Other	
MMLL	Moss, lichens, litter/duff
BARN	Barren, rock, gravel, soil
NNNN	Does not fit any category; unable to assess

S-Class Upper Layer Canopy Closure (field 65) – Required (for each S-Class in the BpS) **–** From table 3-10 below (or software drop-down menu), select / enter the code for the estimated canopy closure of the upper vegetation layer.

Table 3-10. Upper layer canopy closure codes.

Code	Percent Canopy Closure
0	Zero percent
0.5	0-1 percent
3	2-5 percent
10	6-15 percent
20	16-25 percent
30	26-35 percent
40	36-45 percent
50	46-55 percent
60	56-65 percent
70	66-75 percent
80	76-85 percent
90	86-95 percent
98	96-100 percent
XX	Could not assess

S-Class dominant species *(fields 66 to 69)*

These fields differ from fields 27-30 (the BpS Indicator Species) in that these represent the *dominant species* found in **each** S-Class in the stratum. Often, however, the dominant species are the same as the indicator species.

Worksheet or Field Form: For fields 66-69, enter from one to four dominant species in each S-class. If you are not recording NRCS plant codes, we recommend that you later check against the NRCS plant species code (at www.frcc.gov under NIFTT Resources) and, if different, change for consistency in communicating data.

Software: The program will automatically populate field 66 with a dominant species default value (the indicator species from field 27); however, if you have more accurate local values, use these. (Note: for uncharacteristic classes, you must choose from the drop-down menu.) See the Software User Guide (at www.frcc.gov under the Software tab) for shortcuts in determining the dominant species.

S-Class Dominant Species 1 (field 66) – Required (for each S-Class in the BpS) **–** See directions above.

S-Class Dominant Species 2 (field 67) – Not Required **–** See directions above.

S-Class Dominant Species 3 (field 68) **–** Not Required **–** See directions above.

S-Class Dominant Species 4 (field 69) – Not Required – See directions above.

S-Class Fire Behavior Fuel Model (field 70) – Not Required **–** Select / enter the appropriate fire behavior fuel model from Anderson's (1982) 13 Standard Fire Behavior Fuel Models in table 3-11 (or software drop-down menu).

Table 3-11. Anderson's (1982) 13 Standard Fire Behavior Fuel Models.

F M number	Vegetation types	Fire behavior	Fuels
0	Non-vegetated		
1	Perennial grasslands, annual grasslands, savannahs, grass-tundra, grass-shrub with < 1/3 shrub or timber	Rapidly-moving	Cured fine, porous herbaceous; .5 to .9 tons surface fuel-load per acre; .5- to 2-foot depth
2	Shrub, pine, oak, pinyon-juniper with < 2/3 shrub or timber cover	Moderate spread in herbaceous with added intensity from litter/wood and production of firebrands	Fine herbaceous surface cured or dead, litter, dead stem or limb wood; 1 to 4 tons surface fuel-load per acre; .5- to 2-foot depth
3	Tall grassland, prairie, and meadow	Fast-moving with wind, but not as fast as FM 1	Tall herbaceous surface with > 1/3 dead or cured; 2 to 4 tons fuel-load per acre; 2- to 3-foot depth
4	Coastal/sierra chaparral, pocosin shrub, southern rough shrub, closed jack pine (*Pinus banksiana*), pine barrens	Fast-moving and intense	Flammable foliage and small dead woody material with or w/o litter layer; 10 to 15 tons fuel-load per acre; 4-to 8-foot depth
5	Moist or cool shrub types (laurel, alder, manzanita, chamise), forest/shrub, regeneration shrubfields after fire or harvest	Slow-moving and low to moderate intensity	Green foliage with or w/o litter; 3 to 5 tons per acre; 1- to 3-foot depth
6	Pinyon-juniper w/ shrubs, southern hardwood/ shrub w/ pine, frost-killed Gambel oak (*Quercus gambelii*), pocosin shrub, chamise, chaparral, spruce-taiga, shrub-tundra, hardwood slash	Moderate spread and intensity, not as fast/ intense as FM 4, but faster than FM 5	Flammable foliage but shorter and more open than FM 4 w/ less dead, small wood and litter; 4 to 8 tons per acre; 2- to 4-foot depth
7	Palmetto-gallberry w/ or w/o pine overstory, black spruce (*Picea mariana*)/shrub, southern rough, slash pine/gallberry (*Ilex glabra*)	Fast-moving, even at higher dead fuel moisture contents	Flammable foliage, even when green; 4 to 6 tons per acre; 2- to 3-foot depth
8	Closed-canopy short-needle conifer types, closed-canopy broadleaf or hardwood types	Typically slow-moving with low intensities; can move rapidly with high intensity with very low fuel moistures and hot/dry/windy	Usually low- to moderately-flammable foliage with litter or scattered vegetation understory; 4 to 6 tons per acre surface fuels; .1- to .5-foot depth
9	Long needle conifers (for example, ponderosa pine), oak-hickory and similar hardwood types	Fast-moving fires with moderate to high intensity depending on amount of surface fuel	Flammable foliage with needle or leaf litter and some dead, downed woody material; 3 to 4 tons per acre; .1- to .5-feet
10	Any forest type with > 3" dead, downed woody fuels	High fire intensity with low fuel-moisture and fast moving with wind	Dead, downed > 3" woody fuels and litter; 10 to 14 tons per acre of total surface fuel < 3"; .5- to 2-foot depth
11	Light-logging slash, partial-cut slash	Fast-moving and low to moderate intensity with wind	10 to 14 tons per acre; total fuel load < 3"; .5- to 2-foot depth
12	Moderate and continuous logging slash in clearcuts or heavy partial cuts and thinned areas	Fast-moving and moderate intensity fire	30 to 40 tons per acre; total fuel load < 3"; 2- to 3-foot depth
13	Heavy and continuous logging slash in clearcuts or heavy partial cuts and thinned areas	Fast-moving and high intensity fire	50 to 60 tons per acre; total fuel load > 3"; 2- to 4-foot depth

S-Class Reference Percent Composition (field 72) – Required – Enter an estimate (central tendency) of the reference condition composition percentage using a whole integer for each S-Class in the stratum. (Uncharacteristic classes will always be "0" because such classes did not occur in natural ecosystems)

Worksheet: Refer to the reference condition summary tables, regional values, or use your local estimates.

Software or Field Form: The data entry program will automatically populate this field with the reference condition default value; you may replace this default value with more accurate local data.

S-Class Current Percent Composition (field 73) – Required – Enter an estimate (central tendency) of the current composition percentage (in an integer form, using no decimal) for each S-class in the stratum, including any uncharacteristic classes. Use local data such as aerial photographs, maps, or walk-throughs. The sum of entries for the classes must total 100 percent. Also note that, if a given S-Class no longer exists but was present during the reference period, enter zero for the integer.

> ***Note***: In rare cases, a given succession class for the current period might comprise 100 percent of a given BpS stratum, whereas multiple succession classes may have occurred during the reference period. Such situations usually reflect a scale issue resulting from topographic anomalies or large disturbances that recently affected the entire stratum. For example: 1) infrequent and rare interval (> 35 years) stand-replacement regimes that have an absence of mosaic effect due to lack of barriers to fire spread or where the BpS is restricted to a small contiguous area, such as on the top of a mountain; and 2) frequent interval (< 35 years) stand-replacement regimes, such as shrubland or grassland, that tend to be dominated by one succession class, irrespective of the extent or presence/absence of barriers to fire spread. Similarly, in a long interval, stand-replacement regime with a large geographic extent that does not have barriers to fire spread, most of the area could be in one succession class at any one time period. For example, the first year post-fire, there may be 100 percent in S-class A, five years post-fire, there may be 100 percent in S-class C, seven years post-fire there may be 100 percent in S-class D, and so on. If you believe your data for the current period reflect such anomalies, you can adjust your reference condition data in field 72 to account for such scale-induced "errors" (see Appendix B: Suitable Reasons for Replacing Default Reference Condition Values with Local Values.

> ***Note:*** If the stratum contains more than one uncharacteristic S-Class, use only one uncharacteristic code from the code sheet, as follows. If, for example, uncharacteristic timber harvest (UTHV) has affected 20 percent of the stratum as opposed to a lesser amount of uncharacteristic pattern (UPAT) caused by that timber harvesting, record only the primary cause (UTHV) on your form.

S-Class Representative Photo (field 74) – Not Required **–**

Worksheet or Field Form: Enter a name and location for the photo (a pathway on your computer or other location indicating where the photo is stored).

See the Software User Guide (www.frcc.gov) for detailed instructions on incorporating digital photos into your project database.

S-Class Representative Photo Date (field 75) – Not Required **–** Enter the date the Class Representative Photo was taken as an 8-digit date in the MM/DD/YYYY format.

Similarity, departure, relative amount, and FRCC calculation fields (fields 77-104)

> ***Worksheet Note*** : The fields below are not labeled "required" or "not required" as all are required (note that the program automatically calculates the values for software/field form users).
>
> ***Field Form Note****:* At this point, you have entered all the necessary data for this stratum. Use the additional stratum data sections on the form for each additional stratum. When you have entered data for all strata, you can use the software program to complete the calculations. Go back to the beginning of this chapter and follow the Software directions to enter the data into the program.
>
> ***Software Note****:* At this point, you have entered all the necessary data for this stratum. Create blank Stratum Data blocks for each additional stratum by clicking on the "New" (New Stratum) button located to the right of the Stratum Number field at the top of the Stratum Data block. When you have entered data for all your strata, check to be sure that the column totals sum to 100 percent, then simply click on the "Report" button in the lower right to automatically compute the FRCC outcomes and generate the associated summary graphs. (Use the page up/down keys or the scroll bar at the right to view the full report).

Stratum S-Class Similarity (field 77) – This percentage represents the similarity of the current amount of the five characteristic classes to the reference condition amount.

Worksheet: Enter the lesser value of fields 72 and 73.

Strata Similarity (field 78) – This is the total of all S-Class similarity values (field 77) for all strata in the project area.

Worksheet: Total and enter the sum of field 77.

Stratum S-Class Percent Difference (field 79) – This percentage represents the difference between the current amount and the reference condition amount of the five characteristic classes.

Worksheet: Use one of the following equations, whichever one applies:

If (field 73 < field 72), difference = ((field 73 – field 72) / field 72) * 100

If (field 73 ≥ field 72), difference = ((field 73 – field 72) / field 73) * 100

Stratum S-Class Relative Amount (field 80) – This classifies the amounts of reference condition S-Classes currently in the stratum relative to modeled amounts for the reference period. See fig. 3-3 below showing the Relative Amount classes on a continuum before completing field 81:

Worksheet: Enter the applicable letter code from table 3-12 below. Compare the value from field 79 with the graph in fig. 3-3 to determine the Relative Amount Class.

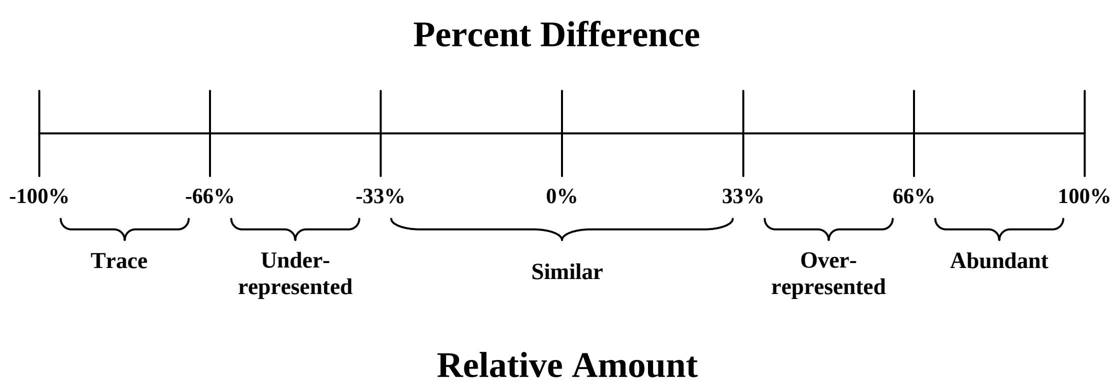


Figure 3-3. Percent Difference and Relative Amount scale, in which the amount of a given S-Class is evaluated against the reference period amount.

Table 3-12. Relative Amount class codes.

Code	Relative Amount Class	Range
T	Trace	(<-66 percent departure)
U	Under-represented	(≥ -66 percent and < -33 percent departure)
S	Similar	(≥ -33 percent and ≤ +33 percent departure)
O	Over-represented	(> +33 percent and ≤ +66 percent departure)
A	Abundant	(> +66 percent departure or > 0 percent uncharacteristic classes)

Stand-level data *(fields 81-82)*

The stand-level fields below (Stand Departure and Stand FRCC) can be used to determine FRCC for stands or other small treatment areas to help managers fulfill various planning and reporting requirements, such as for NFPORS.

Stand Departure (field 81) – This is the categorization that gives a stand its departure rating:

Worksheet: Use one of the following equations and enter the result:

If S-Class Difference (field 79) ≥ 0, then Stand Departure = enter the value from field 79

If S-Class Difference (field 79) < 0, then Stand Departure = enter 0

Stand FRCC (field 82) – For each stand that is a member of this S-Class, compare the value from field 80 with table 3-13 below to determine the stand FRCC.

Table 3-13. Stand FRCC determination and appropriate management response for improvement of landscape condition.

S-Class Relative Amount Class (field 80)	Stand Departure (field 81)	Stand FRCC (field 82)	Improving stand condition if stand is:	Improving landscape condition if S-Class is:
Trace	0	1	Maintained or protected	Recruited
Under-represented	0	1	Maintained or protected	Recruited
Similar	0	1	Maintained or protected	Maintained
Over-represented	S-Class difference (value from field 79)	2	Reduced	Reduced
Abundant	S-Class difference (value from field 79)	3	Reduced	Reduced

Interpretation of table 3-13:
At the stand level, the management goal is to maintain stands residing in succession classes categorized as Trace, Under-represented, or Similar and reduce stands residing in S-Classes categorized as Over-represented or Abundant. **At the landscape level,** the management goal is to recruit succession classes categorized as Trace or Under-represented, maintain S-Classes categorized as Similar, and reduce any succession classes considered to be Over-represented or Abundant.

> ***Note:*** A change of condition class in more than 1 percent of the stratum area may affect the Relative Amount Class (field 80) of the S-Class (field 62) at the landscape level. Consequently, after treatment or disturbance, the changed stratum S-Class estimates will need to be monitored for recalculation of the departure and reclassification of the Relative Amount Class to determine a new Stand FRCC (field 82).

Stratum Area of S-Class Departure (field 83) – This field represents the area (in acres or hectares) that has departed from the reference condition S-Class composition.

Worksheet: Use the following equation:

Field 7 * (field 41 / 100) * ((field 73 – field 72) / 100) = Area departed

Based on the above formula, positive integers (those greater than zero) suggest that the stratum likely contains an excess of that particular S-Class when compared to the reference condition; conversely, negative integers suggest a deficit.

Stratum Current S-Class Departure (field 85) – This represents the deviation of the current S-Class amount from the central tendency of the reference condition amount.

Worksheet: Subtract the value in field 78 from the integer 100.

Stratum S-Class FRCC (field 86) – This field categorizes the S-Class departure according to the three-tier FRCC classification.

Worksheet: Categorize the Current S-Class departure value from field 85 into a fire regime condition class (1, 2, or 3) and enter that value:

1 = ≤ 33 percent (within the reference condition range of variability)
2 = > 33 percent to ≤ 66 percent (moderate departure)
3 = > 66 percent (high departure)

Stratum Current Fire Frequency Departure (field 87) – This represents the deviation of the Current Fire Frequency from the central tendency of the reference condition fire frequency.

Worksheet: Use the following equation: (1 – (lesser value of fields 51 and 52) / higher value of fields 51 and 52)) * 100.

Stratum Current Fire Severity Departure (field 88) – This represents the deviation of the Current Fire Severity from the central tendency of the reference condition fire severity.

Worksheet: Use the following equation:

(1 – (lesser value of fields 53 and 54) / (higher value of fields 53 and 54)) * 100

Stratum Current Frequency-Severity Departure (field 89) – This represents the deviation of the current Fire Frequency-Severity from the central tendency of that of the reference conditions.

Worksheet: Use the following equation: ((field 87 + field 88) / 2).

Stratum Frequency-Severity FRCC (field 90) – This field categorizes Fire Frequency-Severity Departure into an FRCC category.

Worksheet: Categorize the Current Frequency-Severity Departure value from field 89 into a fire regime condition class (1, 2, or 3) and enter that value:

1 = ≤ 33 percent (within the reference condition range of variability)
2 = > 33 percent to ≤ 66 percent (moderate departure)
3 = > 66 percent (high departure)

Stratum Fire Regime Condition Class (field 91) – This is the FRCC rating for the individual stratum.

Worksheet: Enter the higher value of fields 86 and 90.

> ***Worksheet note:*** For the following, return to the Project Data Page fields (page 1 of the Standard Landscape Worksheet)

Stratum Percent of Project Area (field 41). These boxes represent the percent of the project area occupied by each stratum.

Worksheet: Enter the data from the Stratum Data pages (field 41). The sum of your strata must total 100 percent.

Stratum Reference Condition Fire Frequency (field 51) – This is the mean fire interval (MFI) for the Reference Condition Fire Frequency.

Worksheet: Enter the reference condition fire frequency data for each stratum from your Stratum Data pages (field 51).

Stratum Weighted Reference Condition Fire Frequency (field 92) – This is the weighted fire frequency value for each stratum.

Worksheet: Refer to your Stratum Data pages. Calculate for each of your stratum using the following equation: (field 41 / 100) * field 51.

> ***Note***: If the project area includes enough barren area or water to warrant adding either as a separate stratum (at least 20 percent), exclude that percentage from 100 to calculate the above formula. For example, if the project area has a lake in its boundary that occupies 30 percent of the total project area, the formula would be: (field 41 / 70) * field 51.

Project Area Weighted Reference Condition Mean Fire Frequency (field 93) – This is the mean sum of the weighted fire frequencies for all strata.

Worksheet: Add the values from field 92 and enter the total.

Project Area Weighted Reference Condition Mean Fire Frequency Class (field 94) – This field categorizes the weighted mean fire frequency total of all strata into a fire frequency class.

Worksheet: Enter "Frequent" if field 93 is 35 years or less; enter "Infrequent" if it's 36 to 200 years; enter "Rare" if it's more than 200 years.

Stratum Weighted Reference Condition Fire Severity (field 95) – This is the weighted fire severity value for each stratum.

Worksheet: Refer to your Stratum Data pages. Calculate for each of your stratum using the following equation: (field 41 / 100) * field 53.

> ***Note***: If the project area includes enough barren area or water to warrant adding either as a separate stratum (at least 20 percent), exclude that percentage from 100 to calculate the above formula. For example, if the project area has a lake in its boundary that occupies 30 percent of the total project area, the formula would be: (field 41 / 70) * field 53.

Project Area Reference Condition Weighted Mean Fire Severity (field 96) – This is the mean sum of the weighted fire severities for all strata.

Worksheet: Add the values from field 95 and enter the total.

Project Area Reference Condition Fire Severity Class (field 97) – This field categorizes the weighted mean fire severity total of all strata into a fire severity class.

Worksheet: Enter "Low" if field 96 is less than 25 percent; enter "Mixed" if it's 26 to 75 percent; enter "Replacement" if it's more than 75 percent.

Project Area Natural Fire Regime Group (field 98) – This field categorizes the project area into a natural fire regime group.

Worksheet: Enter the numeral indicating the natural fire regime group based on the combination of values from fields 94 and 97:

- I – 0 to 35 year frequency, low to mixed severity
- II – 0 to 35 year frequency, replacement severity
- III – 35 to 200 year frequency, low to mixed severity
- IV – 35 to 200 year frequency, replacement severity
- V – 200+ year frequency, any severity

Stratum Current S-Class Departure (field 85) – Enter the current S-Class Departure data from your Stratum Data pages (field 85).

Stratum Weighted S-Class Departure (field 99) – This is the S-Class departure weighted average for each stratum.

Worksheet: Calculate for each of your stratum using the following equation and enter the values (write as an integer using no decimal): (field 41 / 100) * field 85.

> ***Note***: If the project area includes enough barren area or water to warrant adding either as a separate stratum (at least 20 percent), exclude that percentage from 100 to calculate the above formula. For example, if the project area has a lake in its boundary that occupies 30 percent of the total project area, the formula would be: (field 41 / 70) * field 85.

Project Area Weighted S-Class Departure (field 100) – This is the sum of the S-Class weighted departures for the project area.

Worksheet: Add the values from field 99 and enter the total.

Stratum Fire Frequency-Severity Departure (field 89) – Enter the values from field 89 of your Stratum Data pages.

Stratum Weighted Fire Frequency-Severity Departure (field 101) – This is the fire frequency-severity departure weighted average for each stratum.

Worksheet: Calculate for each of your stratum using the following equation:

(field 41 / 100) * field 89.

> ***Note***: if your project area includes enough barren area or water to warrant adding either as a separate stratum (at least 20 percent), exclude that percentage from 100 to calculate the above formula. For example, if your project area has a lake in its boundary that occupies 30 percent of the total project area, the formula would be: (field 41 / 70) * field 89.

Project Area Weighted Fire Frequency-Severity Departure (field 102) – This is the sum of the fire frequency-severity weighted departure for the project area.

Worksheet: Add the values from field 101 and enter the total.

Project Area S-Class or Fire Frequency-Severity Weighted Mean Departure (field 103) – This field is the higher of the two departures (that is, the vegetation or fire frequency-severity variables).

Worksheet: Enter the higher value of fields 100 and 102

Project Area Fire Regime Condition Class (field 104) –

Worksheet: From field 103, categorize the departure value for your project area into a fire regime condition class:

1 = ≤ 33 percent (within the reference condition range of variability)
2 = > 33 percent to ≤ 66 percent (moderate departure)
3 = > 66 percent (high departure)

Completing the Standard Landscape Worksheet graphs

Worksheet: Follow the procedures below to graph your results

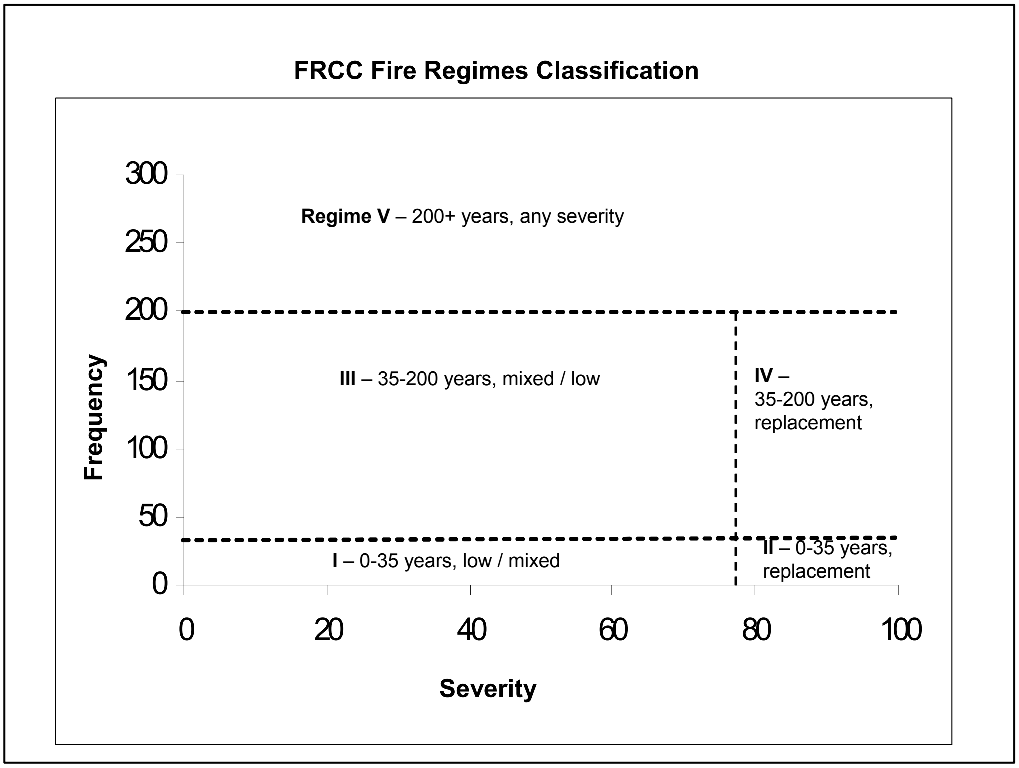


Figure 3-4. Graph of fire regime groups.

Fire Regime Classification graph

> ***Note***: this graph can be used for individual stratum as well as for your overall project area.
> ***Note***: For any non-fire BpS strata, use "Regime V" as the default entry.

Step 1. On the Y-axis, place a mark representing your project area's Fire Frequency (from field 93).
Step 2. On the X-axis, mark your project area's Fire Severity (from field 96).
Step 3. Now simply integrate those two variables. That is, project the Y-axis value horizontally and project the X-axis value vertically. The intersection of those lines represents your project area's dominant fire regime.

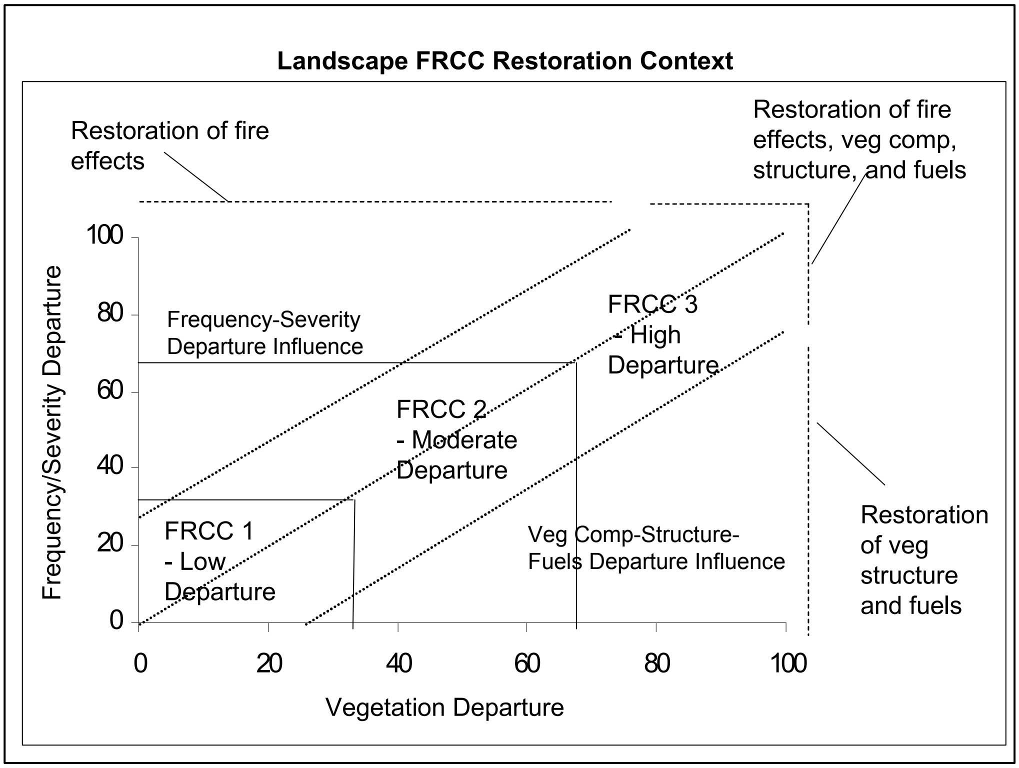


Figure 3-5. FRCC graph with restoration context.

Landscape FRCC Restoration Context graph

(Note: this graph can be used for individual stratum as well as for your overall project area.)

Step 1. On the Y-axis, place a mark representing your project area's Frequency-Severity Weighted Departure (from field 102).
Step 2. On the X-axis, mark your project area's Vegetation Weighted Departure (from field 100).
Step 3. Now integrate those two variables. Again, project the Y-axis value horizontally and project the X-axis value vertically. The intersection of the two lines represents your project area's FRCC.

> ***FRCC graph note***: The graph margins contain notes interpreting the restoration context. For example, if the lines intersect in the upper left-hand side of the graph, the notes in that portion of the graph suggest that restoring fire frequency and severity should have higher priority than vegetation restoration. Conversely, outcomes occurring in the lower right side of the graph suggest that vegetation restoration should perhaps take precedence over fire restoration.

Tracking post-treatment progress toward Fire Regime Condition Class I

> ***Note***: This is neither a field on the worksheet nor in the software. This is a manual, post-treatment calculation.

Progress toward (or regression from) FRCC I can be calculated using pre-treatment and post-treatment assessments with the following "Difference Formula:"

Difference Percentage =
([Pre-treatment field 103 – Post-treatment field 103] / [Pre-treatment field 103]) * 100.

The results from the "difference" calculation will be used to classify progress toward (or regression from) FRCC I as follows:

D – Degradation in FRCC = ≤ - 10 percent difference
N – No change in FRCC = > - 10 percent difference and < + 10 percent difference
I – Improvement in FRCC = ≥ + 10 percent difference

For stand-level treatments, use the following as a guideline for determining if treatments maintain or improve trend:

Table 3-14. Management implications for the stand-level fire regime condition class based on the S-Class relative amount.

S-Class relative amount	Stand FRCC	Improving condition if stand is:
Trace	1	Maintained
Under-represented	1	Maintained
Similar	1	Maintained
Over-represented	2	Reduced
Abundant	3	Reduced

Estimation Technique for Determining Landscape and Stand FRCC

Situations might arise in which estimates of landscape and stand FRCC must be quickly generated for multiple project areas and treatment units simultaneously. That is, some management situations do not allow sufficient time for conducting in-depth FRCC assessments over broad areas containing similar biophysical settings and fire regimes. If you have an FRCC map that was developed following the FRCC Standard Landscape Mapping Method (using the FRCC Mapping Tool) to map landscape and/or stand FRCC using nationally accepted reference conditions, you can use the map for pre-treatment estimation of FRCC.

However, if you do not have a map developed via the FRCC Standard Landscape Mapping Method (using the FRCC Mapping Tool), we recommend that you strategically conduct the Standard Landscape Worksheet Method on at least one representative BpS stratum that comprises the majority of the project area. While conducting the landscape assessment, conduct the stand assessment on at least one (but ideally more) of the typical treatment units. After completion of these assessments, it should then be possible to estimate landscape and/or stand FRCC for similar project areas and treatment units that have not been assessed using Standard Landscape Worksheet Method. FRCC estimation can be supplemented by additional project area and treatment unit information, such as aerial photographs and orthoquads. As this estimation technique is based on documented FRCC assessment procedures, it may be adequate for non-controversial project areas and treatment units.

To organize a strategic assessment and subsequent estimation, we recommend use of an Excel spreadsheet. For the project areas and treatment units on which you've conducted assessments using the FRCC Guidebook process, use the spreadsheet to track key attributes of the biophysical settings. The landscape FRCC graph can also be used to record the departure and FRCC of landscapes in a visual format.

Coarse-scale succession class codes and descriptions

Table 3-15. Coarse-scale S-Class codes and descriptions for the standard 5-box model.

S–Class code & description	Process	Forest & woodland	Shrubland & grassland
A: Characteristic; Early-seral	Post-replacement disturbance; young age	Single layer; fire response shrub, graminoids, and forbs; typically < 10% tree canopy cover; standing dead and down	Fire response forbs; resprouting shrubs; resprouting graminoids
B: Characteristic; Mid-seral Closed	Mid-successional; mid-age; competition stress	One to two upper layer size classes; > 35% canopy cover (crown closure estimate); standing dead & down; litter/duff	Upper layer shrubs or grasses; < 15% canopy cover (line intercept)
C: Characteristic; Mid-seral Open	Mid-successional; mid-age; disturbance-maintained	One size class in upper layer; < 35% canopy cover; fire-adapted understory; scattered standing dead and down	Upper layer shrubs or grasses; > 15% canopy cover shrubs
D: Characteristic; Late-seral Open	Late-successional; mature age; disturbance-maintained	Single upper canopy tree layer; one to three size classes in upper layer; < 35% canopy cover; fire-adapted understory; scattered standing dead and down	Upper layer shrubs or grasses; < 15% canopy cover
E: Characteristic; Late-seral Closed	Late-successional; mature age; competition stress	Multiple upper canopy tree layers; multiple size classes; > 35% canopy cover; shade-tolerant understory; litter/duff; standing dead and down	Upper layer shrubs or grasses; > 15% canopy cover shrubs
UINP–Uncharacteristic; Invasive plants	Invasive plants, such as annual grasses or weeds; difficult to reverse with restoration if large and scattered infestations; most effective to prevent and contain	Commonly spread along roads and in harvest units with mechanical soil surface disturbance; more competitive than native grasses and forbs	Commonly spread along roads and by livestock; more competitive than native plants; usually associated with increase (annual grasses) or decrease (knapweed) in fire frequency
UTHV-Uncharacteristic; Timber mgt. not mimicking natural regime	Timber harvest, stand improvement, and tree planting is not similar to natural regime; road density may be excessive; often lacks dead and down trees and logs; patterns are typically linear or uniform rather than irregular and random or clumped	Commonly involves cutting of large trees & leaving small trees; timber thinning to systematic single tree spacing rather than group trees with variable spacing; planting higher density or different species composition than reference conditions, or off-site stock; high density road system enhancing invasive plant spread, rerouting of water & sediment, and animal displacement/harassment	

Succession Class	Process	Forest & Woodland	Shrubland & Grassland
UGRZ-Uncharacteristic; Grazing mgt. not mimicking natural regime	Grazing season, frequency, and intensity is not similar to natural regime; pattern is often uniform vs. irregular utilization	Often associated with loss of shrub and grass understory; spread of invasive weeds	Decrease in desirable forage species; increase in less desirable and invasive species
UFUS–Uncharacteristic; Fuels/succession	Reference condition disturbance frequency is beyond maximum allowing fuel accumulation or structure that did not occur during that time period	Usually associated with change to larger patch size and loss of patch mosaic with more contiguous heavy fuels	Usually associated with change to larger patch size and loss of patch mosaic with more contiguous upper layer fuels
UFEF-Uncharacteristic; Post-fire effects more severe than during reference period	Effects of fire on plants, soil, water, and air more severe than in reference conditions because of higher or different fuel loads; difficult to reverse with restoration	Commonly occurs in areas with heavy contiguous fuels due to uncharacteristic succession, timber mgt., or insect-disease effects; loss of large trees, excessive smoke, soil erosion, increased water temperatures	Commonly occurs in areas with contiguous upper layer fuels due to uncharacteristic succession or invasive plants
USHD-Uncharacteristic; Soil/hydrologic disturbance more severe than during reference period	Changes or diversion of flow, channelization, loss of biota, sedimentation, or changes in evapotranspiraton; increased soil erosion, compaction, or displacement	In forest stream chanelization, changes in vegetation evapotranspiraton and shift in flow amounts. In woodland, the loss of understory herbaceous cover of soil resulting in increased erosion; increased vegetation evapotranspiraton reducing flow from springs; loss of beaver (*Castor canadensis*) and associated ponds & cutting.	Reduced width in wet riparian zones or drying that change fire behavior & effects. Loss of upland soil cover resulting in increased soil erosion; increased vegetation evapotranspiraton reducing flow from springs; loss of beaver and associated ponds & cutting allowing fires to spread across riparian zones.
UIDS-Uncharacteristic Insect-Disease Invasive or More Severe	Invasive insects or diseases, or epidemic or level of extent not similar to reference condition patterns	Commonly occurs following uncharacteristic timber harvest of large trees leaving small insect-disease susceptible trees	
UCLR-Uncharacteristic cultural treatments	Cultural treatments do not mimic the reference condition patterns	Timber stand improvements, burned area restoration, or road networks that preclude successional stages or patterns	Range improvements, burned area restoration, roads that preclude successional stages or patterns
UPAT- Uncharacteristic Patch dynamics	Alteration of disturbance regimes have changed the patch pattern	Harvest, fire exclusion, or uncharacteristic fires result in uncharacteristic patterns.	Grazing, fire exclusion, or uncharacteristic fires result in uncharacteristic patterns
UOTH – Uncharacteristic; other disturbances	Other human altered disturbance processes		

FRCC Simple 7 Form Instructions

The FRCC Simple 7 Form was developed largely for training purposes to highlight the seven key variables that determine FRCC in an outline format of the Standard Landscape Worksheet. (Recall that the seven key variables represent the five possible succession classes, plus fire frequency and severity). Although the form, located in Appendix A, was initially intended for training purposes, it can also be used for data entry in the field prior to entering the longer Standard Landscape Worksheet data later in the office. Note, however, that copies of the Simple 7 Form will be necessary when project landscapes contain multiple strata (since the form contains data fields only for a single stratum). To promote data coordination between the various forms, note that the field numbers for each data category on the Simple 7 Form correspond to those on the Standard Landscape Worksheet.

Fields 2, 3, 4, 6, 7, 8, 10, 11, and 15 – Instructions are the same as for the Standard Landscape Worksheet Project Data.

Fields 21, 24, 25, 41, 43, 44, 48, 51, 52, 53, 54, 72, and 73 – Instructions are the same as for the Standard Landscape Worksheet Stratum Data.

Fields 77, 78, 79, 80, 81, 82, 83, 86, 87, and 88 – Instructions are the same as for the Standard Landscape Worksheet Similarity, Departure, Relative Amount, and FRCC calculation fields.

Fire Frequency Similarity – Divide the lesser value of fields 51 and 52 by the greater of the two and multiply by 100.

Fire Severity Similarity – Divide the lesser value of fields 53 and 54 by the greater of the two and multiply by 100.

Fire Frequency Departure – Subtract the fire frequency similarity value from 100.

Fire Severity Departure – Subtract the fire severity similarity value from 100.

Comments – The comment field figures prominently when using the Simple 7 Form. Record biophysical descriptions of the strata for completion of the Standard Landscape Worksheet, including (but not limited to) Standard Landscape Worksheet fields 27-39, 63-70, existing uncharacteristic types, and any photo information, as well.

Chapter 4: Standard Landscape Mapping Method: FRCC Mapping Tool (FRCCMT) version 2.2.0 for Arc 9.2

Overview

This chapter provides an overview of the FRCC Mapping Tool, which is a geographic information system (GIS) application for conducting geospatial analyses of fire regime condition class. In order to successfully use the Mapping Tool, prospective users should not only have prior GIS experience, but should also be familiar with FRCC principles, concepts, and methods (see Chapter 2).

> ***Note***: This overview provides information on the FRCC Mapping Tool's major components and its use. For further details and step-by-step instructions, please consult the FRCC Mapping Tool User's Guide, the FRCC Mapping Tool Tutorial, and the tool's built-in Help Utility (available at www.frcc.gov).

The FRCC Mapping Tool Method was designed in accordance with the field-based FRCC Standard Landscape Method (Chapter 3). However, important differences exist between the two approaches. Whereas field-based FRCC assessments measure departures in vegetation (succession classes) and fire regimes (frequency and severity), the FRCC Mapping Tool diagnoses FRCC based on vegetation departure only. (GIS-based methods for incorporating fire frequency and severity data are currently under development). The Mapping Tool provides several possible advantages over field-based assessments. Unlike field assessments, which are often subjective and spatially imprecise, the FRCC Mapping Tool yields consistent, objective, and spatially specific output data for multiple scales. The Mapping Tool also yields potentially more accurate results because it evaluates every BpS in the project area, rather than just the dominant two or three as with field-based assessments. In addition, the FRCC Mapping Tool provides an economical way to assess FRCC. For example, the tool can evaluate conditions over much larger geographic areas than are typically covered by field assessments, and few workers and labor hours are required for operating the Mapping Tool. Finally, the tool is relatively easy to learn and understand – a highly desirable trait given the widely varying skill levels found in today's workforce.

FRCC Mapping Tool components

As stated above, the FRCC Mapping Tool is an ArcMap toolbar designed to operate with ArcGIS versions 9.0 to 9.2. The tool requires several sets of geospatial and tabular input data to produce eight output data layers and a summary report, as described below.

Input data

The FRCC Mapping Tool requires three kinds of spatial information in ArcGRID format: a layer (or attribute) depicting biophysical settings (BpS); a layer depicting succession classes (S-Class), and a layer depicting the landscape units (such as reporting units) within which the composition of succession classes is derived.

First, the *Biophysical Settings* (BpS) layer spatially locates each vegetated ecosystem in the analysis area as described by reference condition modeling (see Chapter 2). The tool uses this layer in conjunction with a reference condition table, described below, to display the average amount of each BpS S-Class that existed historically.

Conversely, the *Succession Classes* layer (previously called the *Vegetation-fuel Class* layer in the FRCC Guidebook version 1.2.0) spatially displays the current S-Class amounts for each BpS. This layer contains data for up to five characteristic succession classes (see box model description in Chapter 2), and an S-Class U category to document any uncharacteristic vegetation, such as invasive weeds or unnatural tree encroachment. Both input layers can be obtained from the LANDFIRE Project at www.landfire.gov (under Data Products), which is a convenient source of spatially consistent data (see Appendix D for details). Or, users can develop their own input layers based on plot data, satellite imagery, photo-interpreted vegetation maps, or locally developed models.

The third required spatial input is the *Landscape* layer, which is a reporting units map used for scale-appropriate S-Class analysis as discussed in Chapter 2. The FRCC Mapping Tool can summarize the data for as many as three scales simultaneously. Therefore, the Landscape layer should contain a tri-level nested hierarchy of hydrologic unit codes (HUC) or similar nested classification, such as ECOMAP (ECOMAP 1993; Cleland and others 1997; Winthers and others 2005). Relatively small (10,000 to 40,000 acre) subwatersheds can be used for reporting units where small or patchy fires dominated historically (fire regimes I and II; table 4-1). Mid-scale reporting units, such as 40,000-200,000 acre watersheds, can be used for reporting units where variable-sized mixed-severity fires (Fire Regime III) predominated. Conversely, small- to mid-scale reporting units would be inappropriate for analyzing succession classes in terrain dominated by large, replacement-severity fires, because such fires can falsely appear to skew S-Class composition relative to reference amounts. To avoid erroneous FRCC outcomes, subbasin-sized reporting units spanning several-hundred thousand acres or more are appropriate where biophysical settings are dominated by replacement fire regimes IV and V. As for possible layer sources, users can obtain information about locally available HUC or ECOMAP layers from GIS librarians, agency hydrologists, or soil scientists.

Table 4-1. Guidelines for scale-appropriate succession class analysis with the FRCC Mapping Tool.

Fire regime group	Terrain size, flat/rolling (ac.)	Terrain size, steep/dissected (ac.)	Ref. cond. table landscape level	HUC level	HUC code	HUC size (ac.)	HUC units	ECOMAP units
I – 0-35 years, low / mixed	500 - 5,000	500 - 2,500	1	6	12	10,000-40,000	subwatershed	landtype phase to landtype
II – 0-35 years, replacement	500 - 10,000	500 - 5,000	1	6	12	10,000-40,000	subwatershed	landtype phase to landtype
III – 35-200 years, low / mixed	1,000 - 20,000	1,000 - 10,000	2	5	10	40,000-250,000	watershed	landtype to landtype association
IV – 35-200 years, replacement	20,000 - 500,000	20,000 - 250,000	3	4	8	450,000 average	subbasin	landtype association to subsection
V – 200+ years, replacement	300,000 - 500,000	200,000 - 300,000	3	4	8	450,000 average	subbasin	subsection
V – 200 + years, any severity	1,000 - 20,000	1,000 - 10,000	1	6	12	10,000-40,000	subwatershed	landtype phase to landtype

Finally, a set of tabular input data known as the *Reference Condition Table* is required to inform the FRCC Mapping Tool about the BpS reference conditions derived from modeling (fig. 4-1). In other words, the tool analyzes the BpS and S-Class input layers in conjunction with the tabular data to compare historical S-Class amounts to current amounts for deriving the FRCC departure metrics. The table (in Access database format) lists the S-Class composition (mean percent), the dominant fire regime, and the appropriate analysis scale for each BpS. Note that the FRCC Mapping Tool software package automatically installs several sets of default reference condition tables based on data from the following sources: 1) 186 models created by the FRCC Working Group for the lower 48 states and Alaska (Hann and others 2004); descriptions available at www.frcc.gov (under Resources), 2) 231 models developed during the LANDFIRE Rapid Assessment, which cover the lower 48 states (descriptions available on the LANDFIRE website's RA model description delivery page at http://www.landfire.gov/models_EW.php), and 3) more than 1,000 models produced to date by LANDFIRE National, which will eventually span the entire U.S., including Alaska and Hawaii (the models and associated descriptions for the eastern U.S., Alaska, and Hawaii will be completed on an incremental basis through 2010 and can be accessed via the LANDFIRE website at http://www.landfire.gov/NationalProductDescriptions24.php). The default tables can be edited to better reflect local conditions, or users can develop their own BpS models and reference condition tables using established protocols (see Appendix B; The Nature Conservancy and others 2006).

BpS_Model	Name	A	B	C	D	E	U	FRG	LandscapeLevel
1610110	Rocky Mountain Aspen Forest & Woodland	34	20	8	26	12	0	3	2
1610120	Rocky Mountain Bigtooth Maple Ravine Woodland	7	15	78	0	0	0	3	2
1610160	Colorado Plateau Pinyon-Juniper Woodland	9	20	22	39	9	0	3	2
1610190	Great Basin Pinyon-Juniper Woodland	2	6	24	36	32	0	3	2
1610200	Inter-Mountain Subalpine Limber-Bristlecone Pine Woodland	40	29	31	0	0	0	1	1
1610500	Rocky Mountain Lodgepole Pine Forest	28	47	25	0	0	0	4	3
1610510	Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	13	10	16	52	8	0	1	1
1610520	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodlands	12	28	25	18	18	0	3	2
1610540	Southern Rocky Mountain Ponderosa Pine Woodland	12	15	17	40	16	0	3	2
1610550	Rocky Mountain Subalpine Dry Mesic Spruce Fir Forest and Woodland	36	29	13	23	0	0	4	3
1610560	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	53	28	10	9	0	0	2	1
1610570	Rocky Mountain Subalpine Limber-Bristlecone Pine Woodland	48	30	22	0	0	0	3	2
1610611	Inter-Mountain Basins Aspen-Mixed Conifer Forest & Woodland-- Low Elevation	22	15	9	39	16	0	1	1
1610612	Inter-Mountain Basins Aspen-Spruce-Fir Forest & Woodland-- High Elevation	9	31	56	4	0	0	3	2
1610620	Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	12	17	22	22	27	0	3	2
1610640	Colorado Plateau Mixed Low Sagebrush Shrubland	6	58	35	0	0	0	3	2
1610660	Inter-Mountain Basins Mat Saltbrush Shrubland	11	89	0	0	0	0	5	3
1610700	Rocky Mountain Alpine Dwarf-Shrubland	14	86	0	0	0	0	5	3
1610780	Colorado Plateau Blackbrush-Mormon Tea Shrubland	4	27	68	0	0	0	3	2
1610800	Inter-Mountain Basins Big Sagebrush Shrubland	14	47	27	8	4	0	4	3
1610810	Inter-Mountain Basins Mixed Salt Desert Scrub	24	44	32	0	0	0	5	3
1610820	Mojave Mid-Elevation Desert Scrub	2	98	0	0	0	0	5	3
1610860	Rocky Mountain Lower Montane-Foothill Shrubland	5	13	62	20	0	0	3	2
1610930	Southern Colorado Plateau Sand Shrubland	22	64	14	0	0	0	3	2
1611020	Colorado Plateau Pinyon-Juniper Shrubland	2	3	9	27	59	0	3	2
1611030	Great Basin Semi-Desert Chaparral	0	100	0	0	0	0	4	3
1611071	Rocky Mountain Gambel Oak - Mixed Montane Shrubland - Continuous	11	27	62	0	0	0	3	2
1611072	Rocky Mountain Gambel Oak - Mixed Montane Shrubland - Patchy	6	25	69	0	0	0	3	2
1611150	Inter-Mountain Basins Juniper Savanna	2	3	9	27	59	0	3	2

Figure 4-1. Example of *Reference Condition Table* documenting reference conditions as determined from modeling. Table shows not only the average succession class amounts for each BpS (columns labeled A through U), but also the dominant fire regime (FRG) and the recommended analysis scale (see column labeled Landscape Level).

Output data

The FRCC Mapping Tool produces seven output rasters displaying the FRCC vegetation metrics described in FRCC Guidebook Chapter 3 (see fig. 4.2 below). In addition, the tool generates a summary report, described below, that facilitates data analysis for management planning and documentation. Unlike field-based assessments, which diagnose FRCC for the project landscape and then for individual stands, the FRCC Mapping Tool begins analyzing at the finest scale (30-meter pixel) and then aggregates and summarizes the data upward in scale to strata- and landscape-level units. Specifically, the tool begins by compiling and summarizing the data according to each BpS S-Class and then aggregates those S-Class data to diagnose FRCC for each BpS stratum. Finally, the tool aggregates the strata results for each landscape unit to diagnose FRCC for the coarsest scale. The following paragraphs describe this step-wise process.

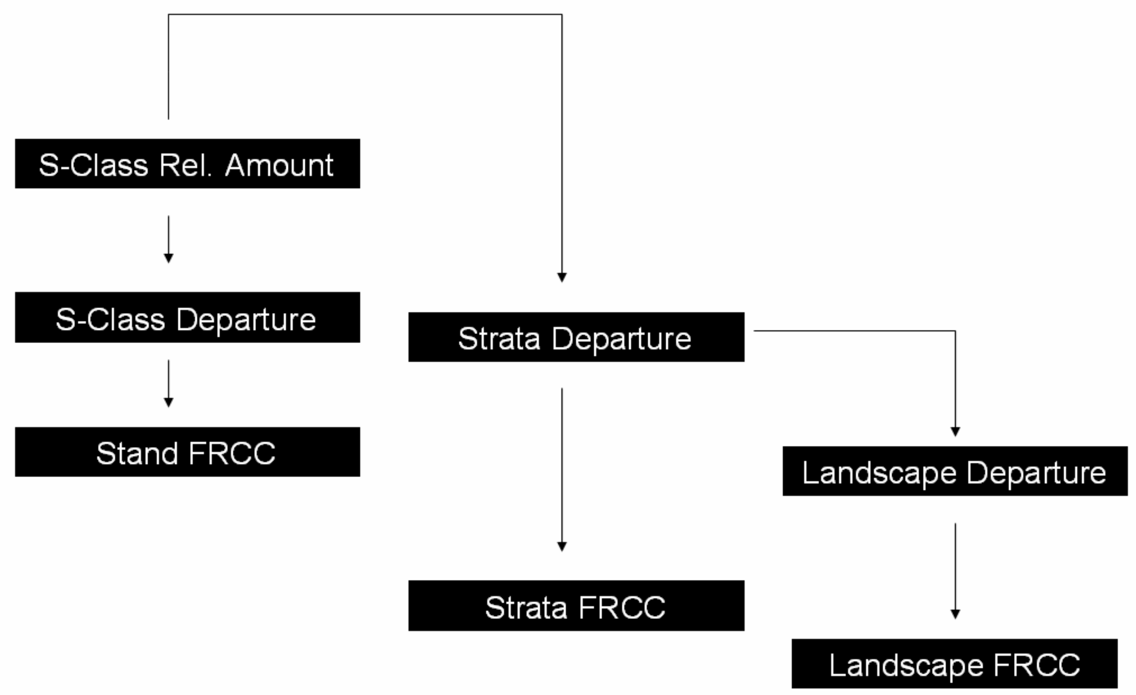


Figure 4-2. Flow chart showing relationship between FRCC Mapping Tool output layers. After using the Percent Difference algorithm to analyze current succession class amounts relative to reference amounts, the Mapping Tool aggregates the data according to the stand, strata, and landscape scales as shown.

In the initial processing step, the tool uses the FRCC percent difference algorithm to compare the current amount of each BpS S-Class to the reference period amount as determined by modeling. The percent difference scale ranges from -100 to +100; zero indicates that the BpS S-Class is similar to the reference amount, negative values indicate comparatively deficient amounts, and positive values represent excessive amounts relative to reference amounts. Although previous tool versions provided an *S-Class Percent Difference* grid as the first output in the ArcMap Table of Contents, that layer is no longer supplied because it has only limited utility. Thus, the percent difference data serve as merely a starting point for subsequently classifying the outputs into more usable FRCC metrics.

The tool then generates the first output grid, which is the *S-Class Relative Amount* layer by classifying the percent difference data into five categories ranging from Trace to Abundant with respect to reference amounts. For example, S-Classes with percent difference values between -33 and -66 percent are classified as Under-represented, whereas succession classes with values between +33 and +66 percent are considered to be Over-represented. Classifying the percent difference outputs thus makes it easier for planners to identify which succession classes should be maintained, reduced, or recruited in the analysis area.

The second stand-level output raster is the *S-Class Departure* layer. This data set is somewhat similar to the percent difference metric, but the departure data are condensed by truncating all negative percent difference values to zero. Each S-Class is thus rated on a scale of zero to 100 percent departure, providing another option for documenting and reporting stand conditions.

The *Stand FRCC* layer represents the final step in the fine-scale classification sequence (fig. 4-3). (The term "stand" is used here only for National Fire Plan Operations and Reporting System [NFPORS] purposes; however, since the map's display units can range in size from single pixels to large groups of pixels in a given BpS S-Class, any subsequent planning would need to delineate which groups truly represent stands suitable for a given management application.) The tool generates this layer by classifying the Relative Amount data according to the three broad fire regime condition classes as follows. Succession classes in the Similar, Under-represented, and Trace classes are categorized as Fire Regime Condition Class 1. (Although spatially deficient, succession classes in the Trace and Under-represented categories are assigned to FRCC 1 because the stands are not necessarily impaired ecologically). Succession classes in the Over-represented category are rated as FRCC 2, and any pixels in the Abundant category are rated as FRCC 3. The Stand FRCC layer is thus the coarsest output among the three stand-scale layers, but simplifying the data helps fulfill management tasks such as NFPORS reporting.

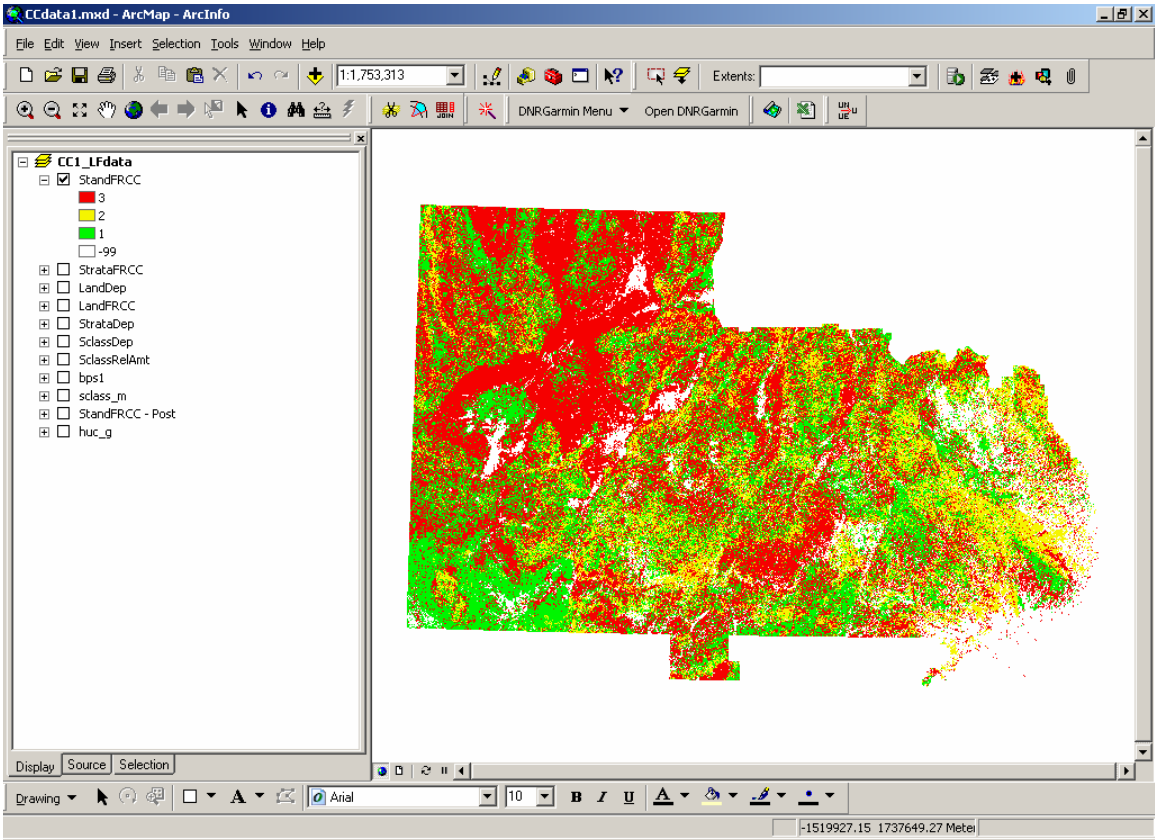


Figure 4-3. An example of the Stand FRCC output layer generated by the FRCC Mapping Tool (*green*: Fire Regime Condition Class 1; *yellow*: Condition Class 2; *red*: Condition Class 3). This output layer is useful for spatially identifying small-scale condition classes, for example, when planning management treatments for stands heavily impacted by long-term fire exclusion.

The FRCC Mapping Tool also produces two mid-scale layers after analyzing BpS S-Class composition according to ecologically appropriate scales as discussed above. First, the *Strata Departure* layer displays the percent departure, from zero to 100, for each stratum (BpS) in the study area. Next, the *Strata FRCC* layer simply classifies those strata departures according to fire regime condition classes 1, 2, or 3, respectively (fig. 4-4).

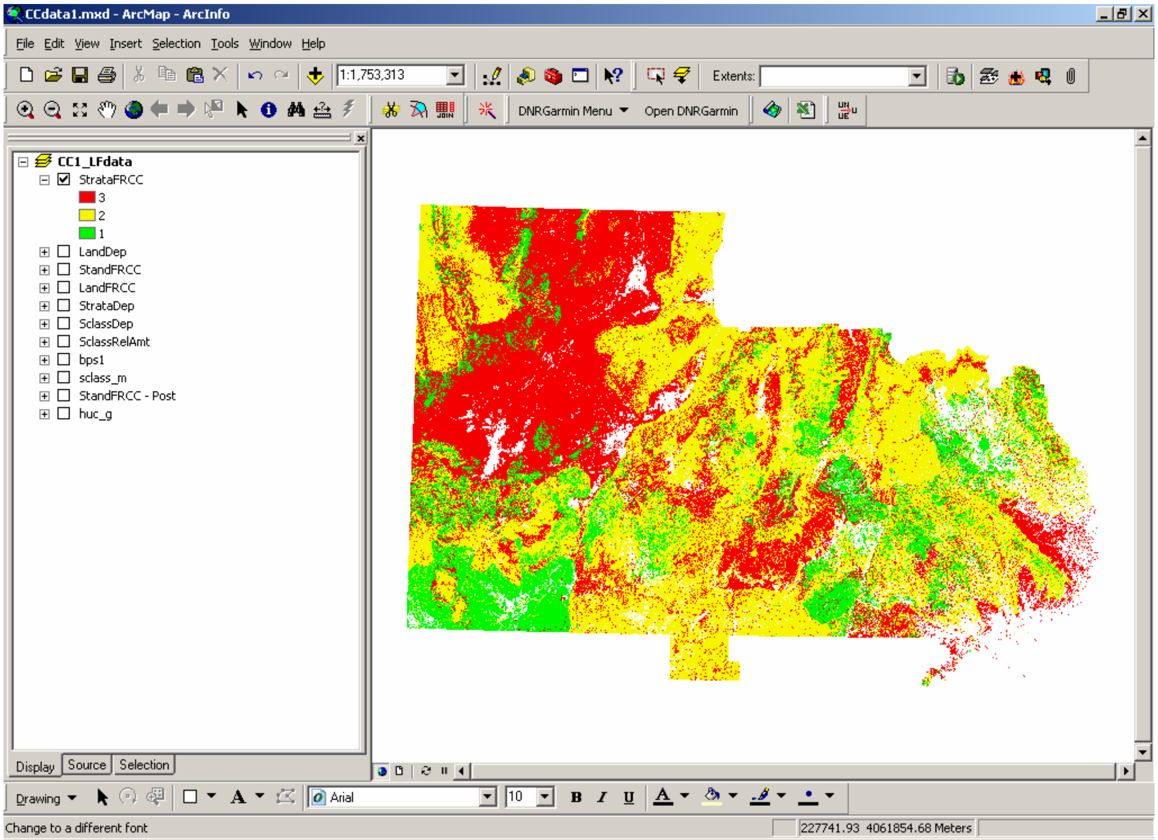


Figure 4-4. An example of the *Strata FRCC* output layer generated by the FRCC Mapping Tool. This output layer is useful for examining the ecological status of individual BpS types within large assessment areas.

The final two output layers, *Landscape Departure* (fig. 4-5) and *Landscape FRCC*, display the large-scale results for each HUC or similarly large landscape unit in the analysis area. The FRCC Mapping Tool generates these data by summarizing departures for all BpS succession classes in each landscape unit based on an area-weighted average formula (Hann and others 2004). For example, landscapes occupied by multiple biophysical settings will reflect a composite value weighted according to strata dominance. The second landscape-scale output layer is the *Landscape FRCC* layer, which is simply a classification of the various landscape departures according to the three fire regime condition classes described above.

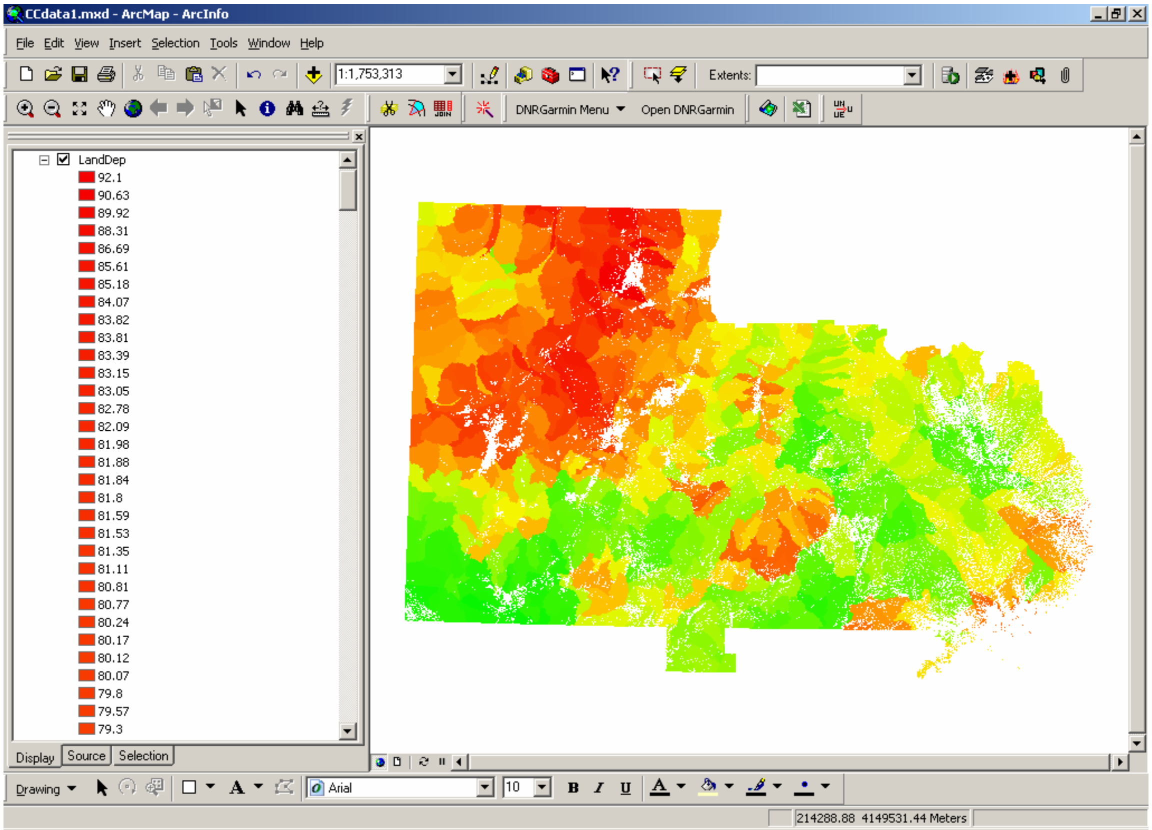
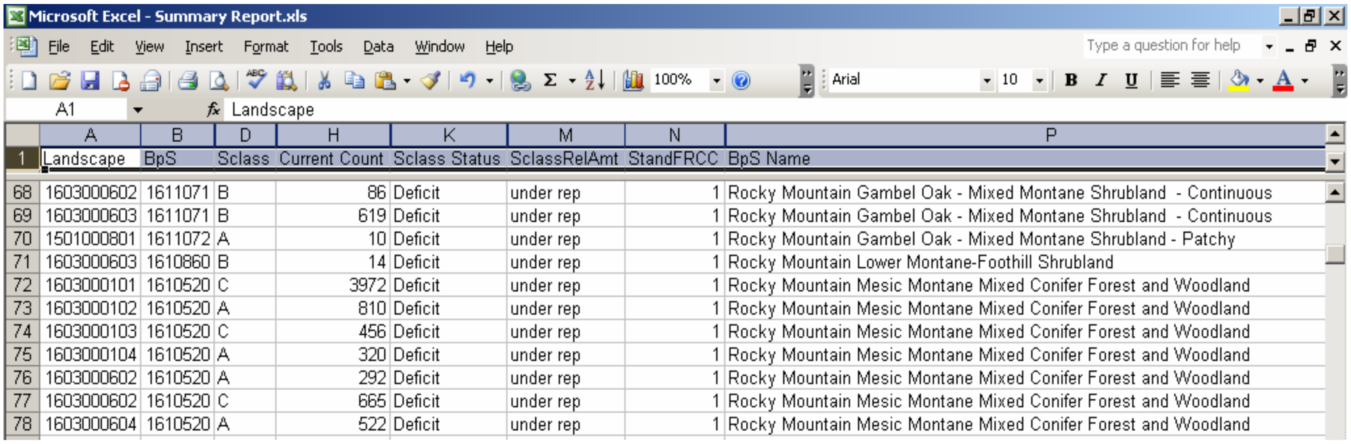


Figure 4-5. An example of the Landscape Departure layer generated by the FRCC Mapping Tool. Note that the departure scale, ranging from 0 to 100 percent, yields finer resolution outputs than the Landscape FRCC layer, which shows results according to three relatively coarse condition classes.

In addition to the geospatial outputs, the FRCC Mapping Tool generates a *Summary Report*. The report, in Excel spreadsheet format, organizes the spatial data in such a way as to facilitate interpretation in a planning context. First, the report displays unique identifying codes for each landscape unit, BpS (stratum), and S-Class in the analysis area. The report summarizes S-Class status according to amounts relative to reference conditions (Trace, Under-represented, Similar, Over-represented, and Abundant) and translates the associated pixel counts into acre-equivalent values to provide ecological and spatial context. Also, the spreadsheet can be sorted in various ways to: 1) help identify stands or larger land units that might benefit from maintenance or restoration treatments, 2) help managers prioritize potential treatment areas, and 3) provide documentation of pre- and post-treatment vegetation status.



Landscape	BpS	Sclass	Current Count	Sclass Status	SclassRelAmt	StandFRCC	BpS Name
1603000602	1611071	B	86	Deficit	under rep	1	Rocky Mountain Gambel Oak - Mixed Montane Shrubland - Continuous
1603000603	1611071	B	619	Deficit	under rep	1	Rocky Mountain Gambel Oak - Mixed Montane Shrubland - Continuous
1501000801	1611072	A	10	Deficit	under rep	1	Rocky Mountain Gambel Oak - Mixed Montane Shrubland - Patchy
1603000603	1610860	B	14	Deficit	under rep	1	Rocky Mountain Lower Montane-Foothill Shrubland
1603000101	1610520	C	3972	Deficit	under rep	1	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
1603000102	1610520	A	810	Deficit	under rep	1	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
1603000103	1610520	C	456	Deficit	under rep	1	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
1603000104	1610520	A	320	Deficit	under rep	1	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
1603000602	1610520	A	292	Deficit	under rep	1	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
1603000602	1610520	C	665	Deficit	under rep	1	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
1603000604	1610520	A	522	Deficit	under rep	1	Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland

Figure 4-6. Example of FRCC Mapping Tool *Summary Report*. Here the spreadsheet has been sorted to identify the locations of succession classes in the Under-represented category with respect to reference amounts. Also note, as in this example, that spreadsheet columns can be hidden to emphasize only the data categories needed for a particular analysis.

This concludes our overview of the FRCC Mapping Tool. If you have any questions about this GIS application, please consult the detailed FRCC Mapping Tool User's Guide and Tutorial (available at www.frcc.gov) or contact the FRCC helpdesk at helpdesk@frcc.gov.

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Appendix A: Forms

FRCC Standard Landscape Method Worksheet
Field Form
Simple 7 Form
FRCC Code Sheet

Fire Regime Condition Class Standard Landscape Worksheet (project page)

Project Data (Fields 1-20)

Registration Code	1	**Project Code**	2	**Project Number**	3	**Charact Date**	4 / /
Examiner Code	5	**Project Name**	6	**Project Area**	7	**acres / hectares (circle one)** (8)	

Georeferenced Project Position:

Latitude	10	**Longitude**	11	**Datum**	15

Photos:

		Photo Dates:
Current	16	17 / /
Reference Condition	18	19 / /

Comments

20

Before completing the section below, complete one stratum page for each stratum in the project landscape

Project Landscape Summary (92-104)

			Strata 1	2	3	4	5	Landscape Totals
Field 41	**Stratum % Composition** - Enter the % of the landscape that each stratum comprises. (field 41 on the stratum page).	41						100%
Field 51	**Stratum Reference Condition (Ref Cond) Fire Frequency** - For each stratum, enter field 51 from the stratum's individual worksheet	51						
Field 92	**Stratum Wtd. RefCond Fire Freqency** - field 41 / [100% - % of Barren or Water BpSs] * field 51	92						
Field 93	**Project Weighted Mean Fire Frequency** (years) - Enter the sum of field 92 columns 1 through 5	93						years
Field 94	**Project Wtd. Mean Fire Frequency Class** - Enter "Frequent" if field 93 is 0-35 years, "Infrequent" if 36-200 years, "Rare" if more than 200 years.	94						
Field 53	**Stratum Ref Cond Fire Severity** - Enter the Ref Fire Severity from field 53 on the stratum worksheet.	53						
Field 95	**Stratum Wtd. Ref Cond Fire Severity** - field 41/ [100% - % of Barren or Water BpSs] * field 53	95						
Field 96	**Project Ref Cond Fire Severity** - Enter the sum of field 95 columns 1 through 5	96						%
Field 97	**Project Ref Cond Fire Severity Class** - Enter "Low" if field 96 is 0-25%, "Mixed" if 26-75%, "Replacement" if greater than 75%.	97						
Field 98	**Project Natural Fire Regime Group** - Enter class based on the combination of field 94 and field 97: I - frequent, low / mixed; II - frequent, replacement; III - infrequent, mixed / low; IV - infrequent, replacement; V - rare, any severity	98						
Field 85	**Stratum Current S-Class Departure** - Enter field 85 from the stratum worksheet.	85						
Field 99	**Stratum Wtd. S-Class Departure** - field 41/ [100% - % of Barren or Water BpSs]* field 85	99						
Field 100	**Project Wtd. S-Class Departure** - Enter the sum of field 99 columns 1 through 5	100						%
Field 89	**Stratum Fire Frequency-Severity Departure** - Enter field 89 from the stratum worksheet.	89						
Field 101	**Stratum Wtd. Fire Freqency-Severity Departure** - field 41/ [100% - % of Barren or Water BpSs] * field 89	101						
Field 102	**Project Wtd. Fire Frequency-Severity Departure** - Enter the sum of field 101 columns 1- 5	102						%
Field 103	**Project Area Vegetation or Fire Frequency-Severity Wtd. Mean Departure** - Enter the greater of S-Class Weighted Departure and Fire Frequency-Severity Weighted Departure (higher of field 100 and 102.)	103						%
Field 104	**Project Fire Regime Condition Class** - Enter "1-Low" if field 103 is 0-33%, "2-Moderate" if 34-66%, "3-High" if 67-100%.	104						

Fire Regime Condition Class Standard Landscape Worksheet (stratum page)

Stratum Data (fields 21-60)

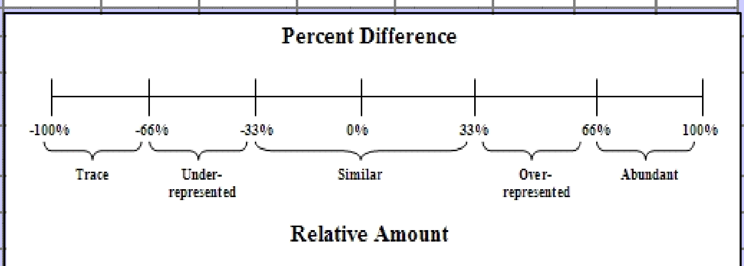
Stratum Num	21	**Stratum Code**	22	**Stratum Name**	23	**Stratum CharDate**	24 / /	**BpS Life form**	25 def
BpS Code	26	**Indicator Species**	27		28		29		30
Local BpS	31	**Land form**	32	**Avg Slope Class**	34	**Insolation Class**	36	**Low Elevation**	38
High Elevation	39	**Elevation Units**	40 ft / m	**Composition**	41 % of Area				
Georeferenced Stratum Position:									
Latitude	43	**Longitude**	44	**Datum**	48				
Current Photo	49	**Photo Date**	50	**Ref Cond Fire Freq**	51 def	**Current Fire Freq**	52	**Ref Cond Fire Sev**	53 def
Current Fire Sev	54	Ref S-Cls % Comp Source	55 def	Cur S-Cls % Comp Source	56 def	Native Amer Burning	57 def	B/C S-Class Break	58 def
D/E S-Class Break	59 def	**Comments**	60						

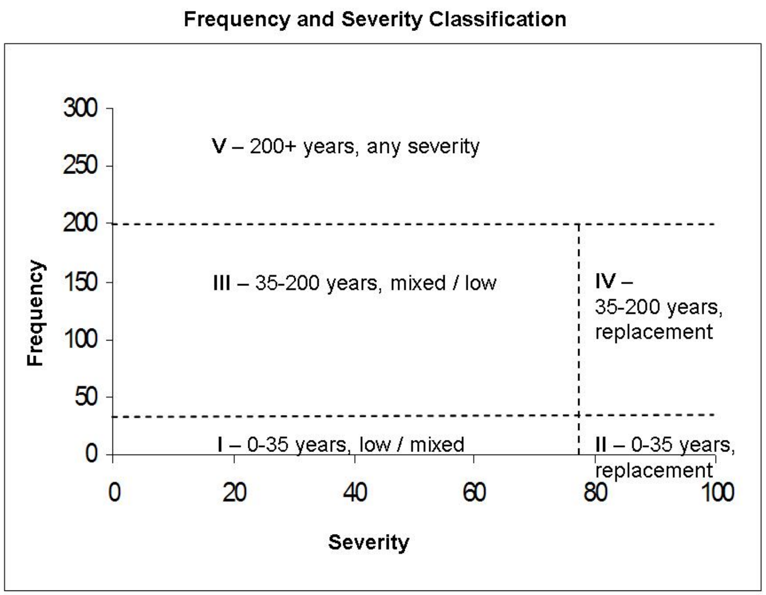
Stratum Data: Succession Class (S-Class) Composition Data (fields 62-75)

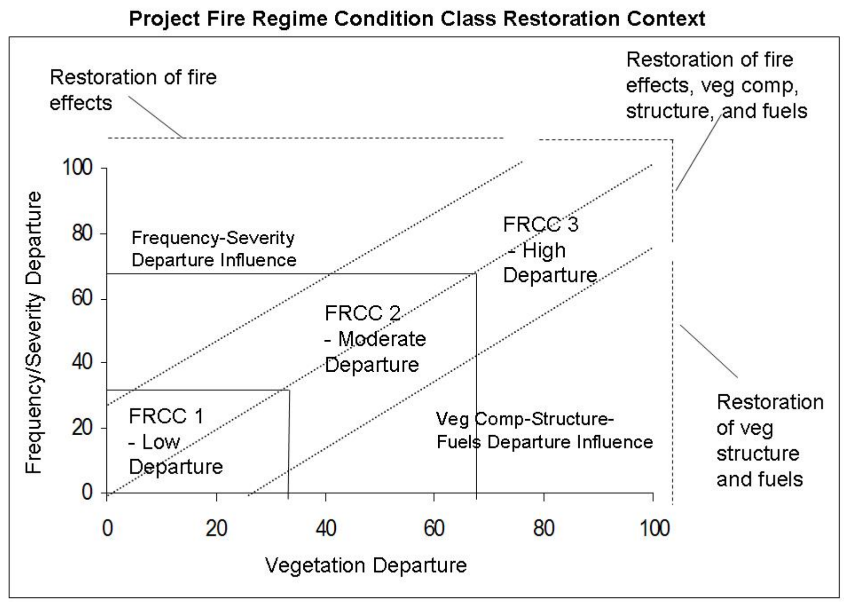
Succes-sion Class (62)	**Uppr Layr Life form** (63)	**Uppr Layr Size Class** (64)	**Uppr Layr Canopy Closure** (65)	**Dominant Species 1 (def)** (66)	Dominant Species 2 (def) (67)	Dominant Species 3 (def) (68)	Dominant Species 4 (def) (69)	Ander-son Fuel Model (70)	**Ref % Comp (def)** **(72)**	**Curr % Comp** **(73)**	Photo (filename/ pathway) (74)	Photo Date (75)
A									%	%		/ /
B									%	%		/ /
C									%	%		/ /
D									%	%		/ /
E									%	%		/ /
										%		/ /

Stratum Data: Strata Totals (77-104)

Field	Description		A	B	C	D	E	____	____	____	Stratum Totals
			S-ClassTypes								
Field 62	S-Class (rows above becomes columns here for fields 62, 72 and 73)	62	A	B	C	D	E	____	____	____	
Field 72	**Reference Percent Composition.** Enter the values from field 72 above.	72						0	0	0	100%
Field 73	**Current Percent Composition.** Enter the values from field 73 above.	73									100%
Field 77	**S-Class Similarity.** Enter the smaller of field 72 (reference) and field 73 (current).	77									
Field 78	**Strata Similarity**. Enter the sum of field 77 for all columns.	78									%
Field 79	**S-Class % Difference.** If (f73<f72) diff = ([f73-f72]/f72)*100 or if (f73 ? f72) diff = ([f73-f72]/f73)*100	79						100	100	100	
Field 80	**S-Class Relative Amount.** "Trace" if field 79 is <-66, "Under-represented" if f79 ? -66 to < -33%, "Similar" if ?-33 to ?33%, "Over-represented" if f79 >33 to ?66 %, "Abundant" if >66%.(see figure)	80						Abundant	Abundant	Abundant	
Field 81	**Stand Departure.** If f79 ? 0 enter f79 value, if f79 < 0 enter 0	81									
Field 82	**Stand FRCC.** If f80 = Trace, Under-rep, or Similar, enter FRCC 1; if f80 is Over-rep, enter FRCC 2; if Abundant, enter FRCC 3.	82									
Field 83	**Area of S-Class Departed.** Field 7*(f41/100) * ([f73-f72]/100)	83									
Field 85	**Stratum Current S-ClassDeparture.** Subtract the value in field 78 from 100	85									%
Field 86	**Stratum S-Class FRCC.** "1" if field 85 is ? 33%, "2" if 34-66%, "3" if 67-100%.	86									
Field 87	**Stratum Current Fire Frequency Departure.** Calculate: (1- [smaller of field 51& 52 / larger of field 51& 52]) * 100	87									%
Field 88	**Stratum Current Fire Severity Departure.** Calculate: (1- [smaller of field 53 & 54 / larger of field 53 & 54]) * 100	88									%
Field 89	**Stratum Current Frequency-Severity Departure.** Calculate: (field 87 + field 88) / 2	89									%
Field 90	**Stratum Frequency-Severity FRCC.** "1" if field 89 is 0- 33%, "2" if 34-66%, "3" if 67-100%.	90									
Field 91	**Stratum Fire Regime Cond Class.** Enter the greater of field 86 and field 90	91									




Frequency and Severity Classification
300
250
200
150
100
50
0
Frequency
V – 200+ years, any severity
III – 35-200 years, mixed / low
IV – 35-200 years, replacement
I – 0-35 years, low / mixed
II – 0-35 years, replacement
0
20
40
60
80
100
Severity


Project Fire Regime Condition Class Restoration Context
Restoration of fire effects
Restoration of fire effects, veg comp, structure, and fuels
100
80
60
40
20
0
Frequency/Severity Departure
Frequency-Severity Departure Influence
FRCC 3 - High Departure
FRCC 2 - Moderate Departure
FRCC 1 - Low Departure
Veg Comp-Structure-Fuels Departure Influence
Restoration of veg structure and fuels
0
20
40
60
80
100
Vegetation Departure

FRCC Standard Landscape Method Field Form   Page 1

Project Data (fields 1-20)

Registration Code	1	***Project Code***	2	***Project Number***	3	***Charact Date***	4 / /
Examiner Name	5	***Project Name***	6	***Project Area***	7	acres / hectares (circle one) (8)	

Georeferenced Project Position:

Latitude	10	Longitude	11	Datum	15

Photos:		Photo Dates:	Comments:
Current Photo	16	17 / /	
Reference Cond Photo	18	19 / /	20

Stratum Data (fields 21-60)

21	Stratum Num	Stratum Code	22	Stratum Name	23	Stratum Char Date	24	BpS Life Form	25 def	BpS Code	26
Indicator Species	27	28	29	30				Local BpS	31	Land Form	32
Average Slope	34	Insolation Class	36	Low Elevation	38	High Elevation	39	(feet/ meters) 40		Composition	41 % of Area

Georeferenced Stratum Position:

Latitude	43	Longitude	44	Datum	48								
Curr Photo	49			Photo Date	50	Ref Fire Freq	51 def	Current Fire Freq	52	Ref Severity	53 def	Curr Fire Severity	54
Ref Comp	55 def	Curr Comp	56 def	Nat Amer Burn	57 def	B/C Class Break	58 def	D/E Class Break	59 def	Comment	60		

Stratum Data: Succession Class (S-Class) Composition Data (fields 62-75)

S-Class Code (62)	**Uppr Layr Lifeform** (63)	**Uppr Layr Sz Class** (64)	**Uppr Layr Can Clos** (65)	**Dominant Species 1 (def)** (66)	Dominant Species 2 (def) (67)	Dominant Species 3 (def) (68)	Dominant Species 4 (def) (69)	Fuel Model (70)	**Ref Comp (def)** (72)	**Curr Comp** (73)	Class Represent. Photo (74)	Class Represent. Photo Date (75)
A									%	%		/ /
B									%	%		/ /
C									%	%		/ /
D									%	%		/ /
E									%	%		/ /
										%		/ /
										%		/ /
										%		/ /

Stratum Data (fields 21-60)

21	Stratum Num	Stratum Code	22	Stratum Name	23	Stratum Char Date	24	BpS Life Form	25 def	BpS Code	26
Indicator Species	27	28	29	30				Local BpS	31	Land Form	32
Average Slope	34	Insolation Class	36	Low Elevation	38	High Elevation	39	(feet/ meters) 40		Composition	41 % of Area

Georeferenced Stratum Position:

Latitude	43	Longitude	44	Datum	48								
Curr Photo	49			Photo Date	50	Ref Fire Freq	51 def	Current Fire Freq	52	Ref Severity	53 def	Curr Fire Severity	54
Ref Comp	55 def	Curr Comp	56 def	Nat Amer Burn	57 def	B/C Class Break	58 def	D/E Class Break	59 def	Comment	60		

Stratum Data: Succession Class (S-Class) Composition Data (fields 62-75)

S-Class Code (62)	**Uppr Layr Lifeform** (63)	**Uppr Layr Sz Class** (64)	**Uppr Layr Can Clos** (65)	**Dominant Species 1 (def)** (66)	Dominant Species 2 (def) (67)	Dominant Species 3 (def) (68)	Dominant Species 4 (def) (69)	Fuel Model (70)	**Ref Comp (def)** (72)	**Curr Comp** (73)	Class Represent. Photo (74)	Class Represent. Photo Date (75)
A									%	%		/ /
B									%	%		/ /
C									%	%		/ /
D									%	%		/ /
E									%	%		/ /
										%		/ /
										%		/ /
										%		/ /

Stratum Data (fields 21-60)

21	Stratum Num	Stratum Code	22	Stratum Name	23	Stratum Char Date	24	BpS Life Form	25 def	BpS Code	26
Indicator Species	27	28	29	30		Local BpS	31	Land Form	32		
Average Slope	34	Insolation Class	36	Low Elevation	38	High Elevation	39	(feet/ meters) 40	Composition	41	% of Area
Georeferenced Stratum Position:											
Latitude	43	Longitude	44	Datum	48						
Curr Photo	49	Photo Date	50	Ref Fire Freq	51 def	Current Fire Freq	52	Ref Severity	53 def	Curr Fire Severity	54
Ref Comp	55 def	Curr Comp	56 def	Nat Amer Burn	57 def	B/C Class Break	58 def	D/E Class Break	59 def	Comment	60

Stratum Data: Succession Class (S-Class) Composition Data (fields 62-75)

S-Class Code (62)	Uppr Layr Lifeform (63)	Uppr Layr Sz Class (64)	Uppr Layr Can Clos (65)	Dominant Species 1 (def) (66)	Dominant Species 2 (def) (67)	Dominant Species 3 (def) (68)	Dominant Species 4 (def) (69)	Fuel Model (70)	Ref Comp (def) (72)	Curr Comp (73)	Class Represent. Photo (74)	Class Represent. Photo Date (75)
A									%	%		/ /
B									%	%		/ /
C									%	%		/ /
D									%	%		/ /
E									%	%		/ /
										%		/ /
										%		/ /
										%		/ /

Stratum Data (fields 21-60)

21	Stratum Num	Stratum Code	22	Stratum Name	23	Stratum Char Date	24	BpS Life Form	25 def	BpS Code	26
Indicator Species	27	28	29	30		Local BpS	31	Land Form	32		
Average Slope	34	Insolation Class	36	Low Elevation	38	High Elevation	39	(feet/ meters) 40	Composition	41	% of Area
Georeferenced Stratum Position:											
Latitude	43	Longitude	44	Datum	48						
Curr Photo	49	Photo Date	50	Ref Fire Freq	51 def	Current Fire Freq	52	Ref Severity	53 def	Curr Fire Severity	54
Ref Comp	55 def	Curr Comp	56 def	Nat Amer Burn	57 def	B/C Class Break	58 def	D/E Class Break	59 def	Comment	60

Stratum Data: Succession Class (S-Class) Composition Data (fields 62-75)

S-Class Code (62)	Uppr Layr Lifeform (63)	Uppr Layr Sz Class (64)	Uppr Layr Can Clos (65)	Dominant Species 1 (def) (66)	Dominant Species 2 (def) (67)	Dominant Species 3 (def) (68)	Dominant Species 4 (def) (69)	Fuel Model (70)	Ref Comp (def) (72)	Curr Comp (73)	Class Represent. Photo (74)	Class Represent. Photo Date (75)
A									%	%		/ /
B									%	%		/ /
C									%	%		/ /
D									%	%		/ /
E									%	%		/ /
										%		/ /
										%		/ /
										%		/ /

FRCC *Simple 7* Form

Project Code *(Field 2)** __________ Project Number *(3)* ________ Project Char. Date *(4)* ___________
Project Name *(6)* ______________________ Size *(7)* _________ Units *(8) (circle one)*: acres / hectares
Lat *(10)* _______________________ Long *(11)* _______________________ Datum *(15)* __________

Stratum *(21)* ________ Date *(24)* __________ BpS *(25)*:_____________ Pct. of Project Area *(41)* _____%
Stratum Lat *(43)* __________________ Stratum Long *(44)* ___________________Stratum Datum *(48)* _______

Fire Frequency-Severity	Reference *(51 & 53)*	Current *(52 & 54)*	Sim ([smaller/larger]*100)	Dep (100-Sim)
Fire Frequency (yrs) Sim = (smaller/larger)*100				
Fire Severity Sim = (smaller/larger)*100				
Fire Frequency-Severity Departure = (Frequency Dep + Severity Dep) / 2 *(89)*				
Fire Frequency-Severity Condition Class (**1** = 0-33%; **2** = 34-66%; **3** = 67-100%) *(90)*				

Succession Class (S-Class) *(62)*	Reference % *(72)*	Current % *(73)*	Similarity (lower of Ref or Cur) *(77)*	Pct. Difference *(79)*
				if (cur<ref)
				diff = ([cur-ref]/ref)*100
				if (cur ≥ref)
				diff = ([cur-ref]/cur)*100
					Relative Amount[1] *(80)*	Stand FRCC[2] *(82)*

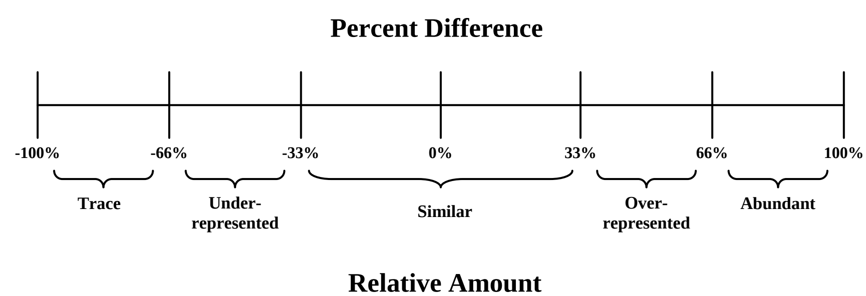
A – Early *(standard)*						
B – Mid-Closed *(std.)*						
C – Mid-Open *(std.)*						
D – Late-Open *(std.)*						
E – Late-Closed *(std.)*						
U – Uncharacteristic	**0**		**0**	**100**	**A**	**3**
Sum	**100**	**100**				
S-Class Departure = (100% minus the Similarity sum) *(85)*						
S-Class Condition Class (**1** = 0-33%; **2** = 34-66%; **3** = 67-100%) *(86)*						

Stratum FRCC: Use the higher of the S-Class *(86)* or Freq-Severity *(90)* FRCC values	

Comments ____
____
____
____
____
____

[1]**Based on Percent Difference:**
T: Trace (-66 to -100%)
U: Under-represented (-66 to -33%)
S: Similar (-33 to 33%)
O: Over-represented (33 to 66%)
A: Abundant (>66%, and all **U** classes)

[2]**Stand FRCC Rules:**
FRCC 1 = Trace, Under-rep., Similar
FRCC 2 = Over-represented
FRCC 3 = Abundant



*Numbers in parentheses correspond to data fields on FRCC forms and software.

FRCC Code Sheet (Vers. 1.3.0)

Average Slope Class(34)

GENTL	0-10
MOD	11-30
STEEP	31-50
VSTEEP	>50

Current S-Class Comp Source (56)

V	Visual estimate
R	Walk through with visual estimate
M	Mapped summary

Insolation Class (36)

LOW	NW, N, NE, E, or flat if cold air drainage
MOD	Flat (≤ 10% slope)
HIGH	W, SW, S, SE or warm air upflow

Stratum BpS Life form (25)

AQ	Aquatic
NV	Non-vegetated
CF	Coniferous upland forest
CW	Coniferous wetland or riparian forest
BF	Broadleaf upland forest
BW	Broadleaf wetland or riparian forest
SA	Shrub-dominated alpine
SU	Shrub-dominated upland
SW	Shrub-dominated wetland or riparian
HA	Herbaceous-dominated alpine
HU	Herbaceous-dominated upland
HW	Herbaceous-dominated wetland or riparian
ML	Moss or lichen dom. upland or wetland
WD	Woodland
OT	Other BpS vegetation life form

S-Class Upper Layer Canopy Closure(65)

0	Zero percent
0.5	>'0-1 percent
3	2-5 percent
10	6-15 percent
20	16-25 percent
30	26-35 percent
40	36-45 percent
50	46-55 percent
60	56-65 percent
70	66-75 percent
80	75-85 percent
90	85-95 percent
98	95-100 percent
XX	Could not assess

S-Class Upper Layer Life form (63)

CONT	Coniferous trees
BRDT	Broadleaf trees
SHRB	Shrubs
HERB	Herbaceous
MOSS	Moss or lichens
NVEG	Non-vegetated
NNNN	Does not fit any category

Reference Condition S-Class Source (55)

N	Non-local expert estimate
D	Determined from lit. review and modeling workshops
R	Regional/state default values from lit. review & model. workshops
L	Local expert estimate
T	Interdisciplinary team (IDT) consensus w/local expert
M	Local expert estimate w/lit. review & modeling
B	IDT consensus from lit. review & modeling workshop w/local expert
F	Published local study w/lit. review & modeling workshops

Ref. Condition Fire Frequency and Native American Burning (57)

C	Used default reference condition summary tables
A	Substantial Native American burning influence included
D	Substantial Native American burning influence but not included
W	Native Amer. burning considered but not different than without
N	Nat. American burning influence not considered

S-Class (62)

Standard Characteristic Code

A	Characteristic; Early-seral, Post-replacement
B	Characteristic; Mid-seral; Closed
C	Characteristic; Mid-seral; Open
D	Characteristic; Late-seral; Open
E	Characteristic; Late-seral; Closed

Standard Uncharacteristic Code

UINPL	Uncharacteristic; Invasive Plants
UTHV	Uncharacteristic Timber Mgt Not Mimicking Natural Regime
UGRZ	Uncharacteristic Grazing Mgt. Not Mimicking Natural Regime
UFUS	Uncharacteristic Succession
UFEF	Uncharacteristic; Fire Effects More Severe Than Natural
USHD	Uncharacteristic; Soil Disturbance More Severe
UIDS	Uncharacteristic Insect-Disease Invasive or More Severe
UOTH	Uncharacteristic; Other Disturbance
UCLR	Uncharacteristic; Cultural
UPAT	Uncharacteristic; Pattern

Stratum Land form (32)

GMF	Glaciated mountains-foothills
NMF	Non-glaciated mountains-foothills
BRK	Breaklands, river breaks badlands
PLA	Plains, rolling plains, plains w/breaks
VAL	Valleys, swales, draws
HIL	Hills, low ridges, benches

Stratum S-Class Relative Amount (80)

Code	***Rel.Amt Class***	***Range***
T	Trace	-66 to -100%
U	Under-represented	-66 to -33%
S	Similar	-33 to 33%
O	Over-represented	33 to 66%
A	Abundant	> 66% , and all U classes

S-Class Fire Behavior Model (70)

1	Short grass
2	Timber with grass and understory
3	Tall grass
4	Chaparral
5	Brush
6	Dormant brush, hardwood slash
7	Southern rough
8	Closed timber litter
9	Hardwood litter
10	Timber with litter and understory
11	Light logging slash
12	Moderate logging slash
13	Heavy logging slash

S-Class Upper Layer Size Class(64)

Coniferous and Broadleaf Trees	
SEED	Seedling - Trees <4.5 feet tall
SAPL	Sapling - Trees ≥ 4.5 ft and < 5.0 inches DBH
POLE	Pole - Trees ≥ 5 inches DBH and < 9 in. DBH
MEDM	Medium - Trees ≥ 9 in. DBH and < 21 in. DBH
LARG	Large -Trees ≥ 21 in. DBH and < 33 in. DBH
VLAR	Very large - Trees ≥ 33 inches DBH
Shrubs	
LOWS	Low - Shrubs ≤3 feet tall
MEDS	Medium - Shrubs > 3 feet tall and < 6.5 feet tall
TALS	Tall - Shrubs ≤ 6.5 feet tall
Herbaceous	
LOWH	Low - Herbaceous ≤ 2 feet tall
TALH	Tall -Herbaceous > 2 feet tall
Other	
MMLL	Moss, lichens, litter/duff
BARN	Barren, rock gravel, soil
NNNN	Does not fit any category; unable to assess

Appendix B: Suitable Reasons for Replacing Default Reference Condition Values with Local Values

Five reasons for replacing the default reference condition data with locally generated data
Replacing default values with local values

Five reasons for replacing the default reference condition data with locally generated data:

There are five suitable reasons for replacing the default reference condition data with locally generated data. These include situations in which:

1) The extent of the area occupied by a given biophysical setting (BpS) is geographically much smaller than that simulated by the default models;

2) Local expert knowledge or results from formal studies in the area indicate a permanently altered BpS;

3) The BpS stratum is constrained by physical or land use barriers (property boundaries) that preclude the disturbance regime from operating naturally, such that any field data reflecting the current condition will likely be dissimilar to those generated by the reference condition modeling;

4) The current succession class (S-Class) composition is now drastically skewed in relation to the modeled reference condition as a result of a very large-scale disturbance, such as a climate-driven stand-replacing fire; and

5) If the user classifies and maps a given stratum or associated succession classes at a much finer resolution than that which was used to simulate default reference conditions during modeling.

The following text provides expanded descriptions of these five reasons for adjusting and replacing default reference conditions. Determine which reason corresponds to your situation:

1) The scale of the geographic extent of the BpS landscape is much finer than that which was used to simulate default reference conditions during

modeling. This would commonly occur where a local administrative unit (such as a National Forest, National Park, or BLM Field Office) is refining FRCC inputs with enhanced input data and reference conditions. To support the investment in making these changes, local expert knowledge or results from studies, inventory, or monitoring of the BpS should indicate a difference in the default type or rate of natural state transitions. These differences include S-Class description, rates of change between succession classes, and disturbance probabilities or severities. Differences should be of an adequate level to change the departure value, FRCC, relative amount, or management implications.

2) Local expert knowledge or results from studies of the BpS indicate a permanently altered system that has changed the type or rate of natural state transitions. Alterations include:

   a) A BpS stratum that is substantially smaller than that which would support the natural diversity of S-Class patches and composition that is in harmony with the natural disturbance regime. Examples include a small fish and wildlife refuge, a small national monument, or a small patch of public land surrounded by private land not managed as wildland.

   b) A BpS stratum with exotic invasives that are more competitive than the dominant native species, thus changing the type or rate of natural state transitions.

   c) A BpS stratum in which a native species critical to S-Class composition and transitions has been extirpated, thus changing the type or rate of natural state transitions.

   d) A BpS stratum drastically altered as a result of climate change, soil loss or type change, or other permanent changes in BpS physical characteristics that heavily affect the type or rate of natural state transitions. An example would be unnatural erosion of a grass-dominated dark, loamy surface soil that leaves a rocky soil prone to shrub domination.

3) The BpS stratum is constrained in size by physical or land use barriers that preclude the functioning of the natural fire regime and resultant natural diversity of S-Class patches and composition. An example would be a BpS stratum with an infrequent or rare replacement fire regime topographically restricted to the upper zone of an isolated mountain range, where just one or two states of vegetation development might be expected to dominate the entire BpS at any given time – unlike the scenario suggested by the coarser-scale default model. In such cases, the localized reference conditions can be adjusted to show up to 100 percent of the S-Class composition occurring in

any one state. (Also note that the BpS in question can also be examined at a coarser scale, to determine if the natural succession class diversity exists in the larger area beyond the project landscape boundaries).

4) The current S-Class composition is now drastically skewed in relation to the modeled reference condition as a result of a very large scale disturbance, such as a climate-driven stand-replacing fire or insect epidemic. Such scenarios reflect a temporal anomaly that can skew S-Class composition relative to that suggested by the default simulation modeling. In Alaska, for example, spruce beetle epidemics in the upland spruce hardwood and coastal boreal transition types can promote dominance by one forest age class (S-Class) for vast expanses far in excess of the scales suggested by default models.

5) Stratum or S-Class classification and/or mapping occurring at a much finer resolution than that simulated during the default reference condition modeling. An example would be a classification based on understory composition, fuels, terrain, soils, or other factors that subdivide BpS succession classes initially described by the default models.

   Note: A common question relates to changing reference conditions in landscapes where the management objective is for a state (S-Class) or disturbance composition that is not in harmony with the natural or permanently altered regime described by the default or localized reference conditions. *This is not a suitable reason for changing the default reference conditions.* From a management implication perspective, landscapes with these management objectives typically require a higher investment in order to convert or maintain a condition that is not harmony with the natural regime. In addition, such management potentially jeopardizes the continued existence of native ecological components and processes. The general goal of FRCC assessment and monitoring is to determine to what extent current management is maintaining or restoring natural systems – that is, how well native ecological components and processes are being conserved. As a performance measure, therefore, FRCC should be used where the land management objectives involve sustainability of the natural fire regime, improvement of forest or rangeland health, and reduction of hazard to native ecological components or processes.

Replacing default values with local values

Users can adjust reference condition data for a given BpS by using the following FRCC modeling protocol. (Note that the seven reference condition variables typically needing adjustment include up to five succession classes, fire frequency, and fire severity):

1) Document which suitable reason from above justifies changing the reference condition from the default.

2) Document that the reference condition has been adjusted in combination with the above reference condition variables through use of the Vegetation Dynamics Development Tool (VDDT) or similar non-spatial model or through a companion spatial model such as Tool for Exploratory Landscape Analysis (TELSA), Landscape Succession Model (LANDSUM), or other similar spatial model.

3) Document the local expert or team making the adjustment and the associated literature and field reconnaissance methods that support the model refinement.

Appendix C: Science Review of FRCC Guidebook Principles and Methods

A science review was conducted of the FRCC Guidebook process (Morgan and others 2007). The following information is a brief summary of the purpose, process, and recommendations of the science review of the Fire Regime Condition Class (FRCC) concept, methods, and applications. Beginning in October of 2003, the group met multiple times, maintained ongoing communications, and developed written material. Membership of the science review team follows:

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A systematic process was used to solicit broad input, independent reviews, written documents, and possible submission of a draft manuscript for formal peer review. The management and policy context in which the methods were developed was taken into consideration and comments were provided on the scientific appropriateness, strengths, and limitations of FRCC. The management objectives and political context surrounding FRCC provided the boundaries of the review. The team was particularly concerned with soliciting and incorporating review from a wide range of scientists and users. The committee sought to address FRCC concepts, methods, and applications and to evaluate FRCC scientific background, strengths, limitations, and recommendations. The review recommended incorporating as many of the committee's findings as possible, recognizing the agencies' ongoing desire to improve the FRCC Guidebook process.

The science committee had initially planned to submit a manuscript to a refereed journal by spring 2005, describing its findings and recommendations. But that objective was not met for several reasons. For example, the committee had insufficient time for evaluating FRCC-related outcomes generated by the LANDFIRE Project. (LANDFIRE findings might be useful for addressing concerns such as how to document and model the historical range of variation and how to evaluate changes in landscape pattern). But LANDFIRE's accelerated production schedule made it infeasible for the FRCC science committee to keep apprised of new findings and possible implications for FRCC methodology. As a result, the committee did not have the time or adequate research results to evaluate whether, or the degree to which, some aspects of the FRCC methodology were scientifically valid. Disagreement among committee members about potential solutions to perceived FRCC shortcomings also resulted, in part, from the lack of LANDFIRE research results.

In general, committee members felt that FRCC theories and principles are largely science-based. And most members agreed that the current methodology provides a potentially useful way to measure ecosystem status with respect to reference conditions while acknowledging the widely varying quality and quantity of data describing pre-settlement conditions. The committee also recognized that revising the basic FRCC methodology to a more robust and strictly objective scientific approach likely would have made FRCC assessments impractical for most managers at the local level. Consequently, no major changes in methodology were made for FRCC Guidebook Version 1.3.0. Nonetheless, the committee identified a number of opportunities for improving the FRCC methodology. For example, after evaluating both the qualitative and quantitative methods, the committee recommended that the qualitative (scorecard) method be revised and subjected to beta-testing, that the resulting quantitative and qualitative forms be identified as version 1.0, and that the Guidebook working group solicit and incorporate comments from scientists and users. After subsequent field testing, the FRCC Working Group decided to eliminate the qualitative and overly subjective FRCC Scorecard method and developed the FRCC Simple 7 Form to provide an introduction to the FRCC assessment process and enhance user understanding (see

Appendix A). In addition, the science review provided 11 other recommendations, listed below.

1. Provide guidance on FRCC science background and context for operational use.
2. Provide guidance on FRCC background theory and key concepts.
3. Clarify uncharacteristic classes.
4. Account for spatial pattern in FRCC.
5. Address the high uncertainty in assessing severity in reference conditions.
6. Use a range of values for reference conditions and determination of current departure.
7. Clarify the difference between point and area fire frequency.
8. Clarify the way to determine which vegetation type the user is assessing.
9. Revise and improve vegetation type reference condition descriptions.
10. Test repeatability and accuracy of field methods.
11. Assemble and develop new guidance for describing historical fire regimes.

The FRCC Working Group reviewed these recommendations, and interacted with the science review team to provide the following responses to satisfy the concerns of both the science committee and the Interagency Fuels Committee (IFC). The IFC indicated that the FRCC Guidebook should be upgraded whenever necessary to address as many of the recommendations as possible, subject to available funding as well as to research conducted by the Forest Service, Department of Interior, Joint Fire Sciences program, and the National Fire Plan. The responses are summarized in table C-1.

Table C-1. Listing of science review team recommendations and working group responses for changes and additions to FRCC Guidebook procedures and information.

Science Review Team Recommendations	FRCC Working Group Responses for Improvement
1. Expand upon science background & context • Explain scientific basis • Credibility of process	**1. Response (Versions 1.2.0 and 1.3.0 Guidebooks)** • Version 1.3.0 Chapter 2 includes more scientific background • Vers. 1.3.0 Chapter 2 now discusses management applications and integration
2. Expand upon background theory and concepts • Synthesis of science background theory and key concepts is terse and needs expansion • Address issues of scale & pattern in more depth	**2. Response** • Vers. 1.3.0 Chapter 2 discusses latest research on scientific background • More discussion about scale has been added to Chapters 2 and 4 • Users should keep apprised of future research, such as from LANDFIRE and subsequent research examining scale and BpS issues • Related training courses, such as **FOR-438 Basic Integrated Fuels Planning Using LANDFIRE Data** addresses scale and pattern issues.
3. Clarify uncharacteristic classes • Lack of descriptions by vegetation type cause confusion and inconsistency • Possibly allow only direct modern human-caused effects	**3. Response** • LANDFIRE Rapid Assessment and National modeling workshops refine BpS descriptions • Consider impact of not classifying uncharacteristic fire effects on soil, etc. These may preclude allowing only direct human-caused effects.
4. Examine landscape pattern issues	**4. Response**

• Explicitly consider changes in pattern as well as composition because ecological processes are closely linked • Uncharacteristic pattern does not capture its importance	• FRCC Guidebook and LANDFIRE have not been able to devise a simple, effective way to measure changes in landscape pattern • Lack of technology that is simple enough to implement consistently. This may preclude our ability to implement anything in the near future.
5. Address uncertainty in assessing fire severity • Severity definition in GTR-87 is limited to first-order effects on the upper layer • Recommend broader definition • Recognize the uncertainty in ability to model or empirically determine severity • Include sources and degree of uncertainty in descriptions	**5. Response** • Evaluation of severity definition suggests no change is merited for use with the FRCC algorithm • Subsequent modeling has helped clarify severity traits by vegetation type • Future researchers should examine the possibility of using the Normalized Burn Ratio (NBR)/ Composite Burn Index (CBI) for current fire severity mapping and possibly of using FOFEM for modeling reference conditions.
6. Use range of variability instead of central tendency as reference • Use range of values for reference conditions of 5 succession classes • Use range for reference conditions of fire frequency and severity • More in keeping with science of historical range of variability	**6. Response** • LANDFIRE statistician recommended examining departure metric that uses a quantile of the maximum of the range; however, subsequent testing suggested too difficult to model with VDDT, especially given the lack of empirical data for most biophysical settings • Tested by reviewing literature in 6 different vegetation types • Literature is inconsistent and incomplete on reporting range and empirical data are often sparse • LANDFIRE agreed to provide simulated range with 90th quantile of maximum from simulations using LANDSUM; however, FRCC Working Group decided to retain use of central tendency until more data become available (July 2006 meeting, Missoula Fire Sciences Laboratory)
7. Clarify difference between point and area fire frequency • Fire frequency in a landscape reflects both how often fires occur and how large those fires are • Because they are estimated from individual and small groups of fire-scarred trees, point estimates usually suggest that fires are more frequent • Area frequency can be estimated from fire-scarred trees by excluding fire years that are recorded only by one or a few trees, but that requires good cross-dating • For many locations, we lack data to describe more than approximate historical fire regimes	**7. Response** • Want area frequency, but point frequency data are more commonly available • Fire rotation method could possibly resolve this issue if enough empirical data were available • LANDFIRE can model area fire frequency reference conditions using LANDSUM software, but unsure how to incorporate into current BpS models • May be able to use NBR and CBI for assessing current area fire frequency, but needs future testing by researchers
8. Clarify how to determine what vegetation type user is assessing • Incorrect determination of Potential Natural Vegetation (PNV) or Biophysical Setting (BPS) can cause major error in FRCC • Explicitly address how to accommodate situations greatly altered by human disturbance	**8. Response** • FRCC Working Group developed vegetation keys by geographic area • Reference condition definition revised to what's restorable • LANDFIRE has improved mapping rules based on indicator species and physical characteristics

9. **Revise vegetation type reference condition descriptions** • Reference descriptions lack sufficient detail for users to understand which one is suited to their location, which others are similar, and where to go for additional information • Descriptions must include the basis for and uncertainty in fire regime and vegetation abundance estimates • Include more information on other disturbances • To be defensible, descriptions need to reflect synthesis of the literature and expert opinion, and to identify references used	**9. Response** • BpS descriptions have been substantially improved by LANDFIRE Rapid Assessment and National modeling workshops • LANDFIRE may produce uncertainty measures; however, we're not sure they will be useful to managers • LANDFIRE modeling workshops included non-fire disturbances • May need additional staff and contract work to produce higher quality descriptions and/or field research to ground-truth and calibrate models
10. Test repeatability and accuracy of field methods • A robust assessment of FRCC accuracy and replication is needed – how well do guidebook assessments and modeling agree with reality across vegetation gradients in landscapes where historical fire regimes are well characterized? • This will inform development of a consistent methodology for defining reference conditions using dendrochronology, paired photos, and other retrospective techniques.	**10. Response** • Robust assessment would be highly useful for improving FRCC definitions, methods and tools • Accuracy assessments/calibration research began in 2005 in Great Basin (Heyerdahl and others 2007, Swetnam 2006) and central Montana (Brown and Hann [in prep]) • TNC has proposed testing in central U.S. • However, research on reference conditions and assessment methods is sorely lacking for many BpS types across U.S.
11. Assemble & develop new guidance for describing historical fire regimes • Add links to existing fire history available from the IMPD • Assemble and develop guidance on field procedures to standardize approaches to characterizing historical fire regimes (dendrochronology; charcoal and pollen; photographs and literature; modeling)	**11. Response** • Possible Joint Fire Science project to expand and increase availability of fire history information • Lack of funding and strategy for research to develop effective methods across all forest and rangeland types • Consistent methods and their associated uncertainty should be provided in FIREMON • Will require working closely with research, some of which began to address this issue in 2005 (see Great Basin, central Montana research cited above)

Appendix D: Overview of LANDFIRE FRCC Geospatial Layers

Background

Fire regime condition class (FRCC) users should also be aware that the LANDFIRE Project has produced a suite of GIS maps documenting FRCC, fire regimes, and other closely related themes across the U.S. Below is an excerpt from the LANDFIRE website (www.landfire.gov) that provides a good overview of this unprecedented landscape mapping project:

LANDFIRE, also known as the Landscape Fire and Resource Management Planning Tools Project, is a five-year, multi-partner project producing consistent and comprehensive maps and data describing vegetation, wildland fuel, and fire regimes across the United States. It is a shared project between the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior. The project has four components: the LANDFIRE Prototype, LANDFIRE Rapid Assessment, LANDFIRE National, and Training/Technology Transfer.

LANDFIRE data products include layers of vegetation composition and structure, surface and canopy fuel characteristics, and historical fire regimes. LANDFIRE National methodologies are science-based and include extensive field-referenced data. LANDFIRE data products are designed to facilitate national- and regional-level strategic planning and reporting of wildland fire management activities. Data products are created at a 30-meter grid spatial resolution raster data set.

LANDFIRE National data products are produced at scales that may be useful for prioritizing and planning hazardous fuel reduction and ecosystem restoration projects; however, the applicability of data products varies by location and specific use, and products may need to be adjusted by local users. LANDFIRE meets agency and partner needs for data to support large landscape fire management planning and prioritization.

The FRCC-related LANDFIRE data products

The LANDFIRE Project consists of both the Rapid Assessment phase (conducted between 2004 and 2005) and the subsequent National phase, which started in 2005 and will conclude in 2009. To date, both phases have produced a number of downloadable FRCC-related maps based on 30-meter pixel resolution across the U.S. Mapping began in the western U.S. and is, at time of writing, proceeding across the eastern U.S. The mapping will then continue into Alaska and Hawaii. (Please visit the Schedule section of www.landfire.gov for progress updates and a map showing progress to date). Below is a brief description of the FRCC-related map layers produced by both the Rapid Assessment and National phases.

Biophysical Settings (BpS) layer:

This map documents the spatial occurrence of reference (pre-settlement) vegetation types in the U.S. before the onset of fire exclusion and other settlement activities. In other words, the map shows the locations of ecosystems in their natural states, as influenced by major disturbances such as fires, insects, and diseases (see Chapter 2).

For more perspective, the following text from Rollins and others (2007) provides a good overview of the LANDFIRE vegetation modeling process that has preceded the BpS mapping to date:

> The objectives of LANDFIRE vegetation modeling were to 1) describe the myriad of disturbance information and transition times that entrain vegetation patterns over time, 2) provide vegetation models for input to LANDSUM, and 3) document the ecological assumptions and information behind the development of the models in the LANDFIRE ModelTracker Database (MTDB). The MTDB is a tool created in Microsoft Access used in LANDFIRE vegetation modeling to track inputs, outputs, assumptions, contributors, peer-review comments, and other data for each model. Information from the MTDB is used as ancillary data in the mapping of biophysical settings, existing vegetation type, succession classes, and surface and canopy fuels.
>
> Vegetation models were developed at regional workshops where over 700 regional ecologists and fire managers developed over 1,200 vegetation models. At these workshops, vegetation and fire ecology experts synthesized the best available science on disturbance dynamics for the vegetation communities found in their regions. Participants were trained in VDDT software and worked in groups to develop vegetation models for each BpS in their respective modeling zones. Extensive internal and external peer review processes followed model development.

Succession Classes (S-Class) layer:

This map documents the spatial occurrence of the current (post-settlement) vegetation status according to as many as five succession classes as defined by the FRCC Guidebook (see Chapter 2). The map documents the spatial array of standard succession classes A through E and up to two subclasses of the uncharacteristic class U for each BpS. Subclass UE represents uncharacteristic exotic vegetation, such as invasive weeds, and Subclass UN represents uncharacteristic situations created by native species, such as when grasslands experience unnatural tree encroachment. (Note that LANDFIRE provides up to two uncharacteristic succession classes, whereas the FRCC Mapping Tool contains only one data field for Class U; however, FRCC Mapping Tool version 2.2.0 provides a utility for merging those LANDFIRE data into one S-Class U (see the FRCC Mapping Tool User Guide – available at www.niftt.gov for more details). The succession classes layer, in combination with the BpS layer, thus provides a remote sensing data set for evaluating the vegetation component of the FRCC algorithm. In addition to documenting pre- and post settlement vegetation across the U.S., note that the LANDFIRE S-Class and BpS maps can also be used as data inputs for operating the FRCC Mapping Tool locally (see Chapter 4).

FRCC layer:

This map produces relatively coarse-scale estimates of FRCC across the U.S., using the departure algorithm and the three condition classes defined by the FRCC Guidebook (see Chapter 2). The FRCC maps were derived according to two different LANDFIRE methods: 1) the Rapid Assessment phase analyzed current succession class composition relative to the reference amounts provided by the BpS layer, and 2) the National phase uses the above two vegetation inputs to conduct landscape simulation modeling to derive FRCC and fire regime maps (Rollins and Frame 2006; Keane and others 2007). Note that, in both cases, the FRCC outputs are based on summaries of vegetation composition across large-scale ecological subsections, and hence the LANDFIRE layers are not as refined as the FRCC diagnoses produced by local field assessments or by the FRCC Mapping Tool (see chapters 3 and 4). In other words, although the LANDFIRE FRCC maps may be useful for state and regional-scale analysis, those outputs cannot be used for finer scale planning such as land use planning, project design, and monitoring.

Fire Regime Groups layer:

The map of fire regime groups documents the spatial occurrence of the five reference (pre-settlement) fire regimes defined by the FRCC Guidebook (see Chapter 2). These maps are derived using two different LANDFIRE methods: 1) the Rapid Assessment mapping phase developed a spatial rule set based on the dominant fire regime listed in each BpS model, and 2) the National phase uses simulation modeling to estimate a spatially specific probability of occurrence for each fire type and then applies a dominant-regime rule set (Rollins and Frame 2006; Keane and others 2007). Specifically, the LANDFIRE National phase uses LANDSUM landscape simulation software (Keane and others 2007) to generate probability outputs for mean fire interval (MFI) and fire severity for each pixel and then applies the following dominant-fire rule set: 1) When the MFI output is less than 35 years and the stand replacement output is less than 66 percent, Fire Regime Group I is assigned; otherwise, Regime II is assigned, 2) when MFI is between 35 and 200 years and the stand replacement output is less than 80 percent, Regime III is assigned; otherwise, Regime IV is applied, and 3) when MFI is greater than 200 years, Regime V is assigned for all fire severity types.

Note that the FRCC and Fire Regime Groups layers may contribute to restoration planning and reporting requirements as set forth by the Healthy Forest Restoration Act of 2003 and the National Fire Plan Operations and Reporting System (NFPORS). Also note that, in addition to the four major FRCC-related layers described above, the LANDFIRE Project has produced the following ancillary layers that are closely related to FRCC: 1) FRCC Departure Index, 2) Mean Fire Return Interval, 3) Percent Low-severity Fire, 4) Percent Mixed-severity Fire, and 5) Percent Replacement-severity Fire. For more information, and to learn how to download any of the above maps, please visit www.landfire.gov.

Glossary

Abundance. The amount of a species. For vegetation, abundance is typically measured as percent areal cover. Other measures include biomass and stems per unit area.

Algorithm. A precise prescription given by a step-by-step description of a solution to a problem.

Area-weighted average: A measure of the relative proportions of different size units in relation to the total area in question. Individual values, such as FRCC strata departure metrics, are first multiplied by each unit's percentage of the total project area and then divided by the total area percentage.

Attributes: Descriptive characteristics of an entity in a database. Location is a mandatory attribute in a global information system (GIS) as is at least one graphic element (that is, point, line, or polygon). The term is often used in GIS to refer to all non-graphic data.

Biophysical unit: A division of the landscape with similar biological and physical characteristics.

Biophysical setting (BpS): A grouping of ecologically similar vegetation types modeled with characteristic disturbance inputs and used for FRCC assessments. In FRCC, this term is synonymous with potential natural vegetation group (PNVG). (See also Historical vegetation, PNV, and Reference condition model).

Box model: A standardized BpS dynamics model with succession classes (boxes or seral states) and defined pathways (transitions) that move vegetation from one class to another via disturbance or succession. Box models are based on state & transition modeling concepts and use the Vegetation Dynamics Development Tool (VDDT) software.

Canopy: Forest or woodland tree biomass above surface vegetation and fuels.

Canopy cover: 1) The proportion of ground – usually expressed as a percentage – that is occupied by the perpendicular projection down onto it of the aerial parts of the vegetation or the species under consideration. The additive cover of multiple strata or species may exceed 100 percent (FGDC 1997). 2) The percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings within the canopy are included (SRM 1989; NRCS 1997). Canopy cover is synonymous with canopy closure (Helms 1998). For woody plants, canopy cover is synonymous with crown cover (NRCS 1997; Helms 1998).

Characteristic/Uncharacteristic: Characteristic conditions and processes are those similar to conditions occurring in the natural or historical regime, whereas uncharacteristic conditions are those that would not have occurred. See "Uncharacteristic."

Class: The box model succession class within each BpS, based on succession (seral) stage, composition, and structure (see table below). Reference conditions for each BpS are based on as many as 5 characteristic classes (A through E); current conditions might have additional classes (called "uncharacteristic").

Seral Stage (see *Seral* definition below)	**Composition & Structure** *Attribute (such as Open)*	*Attribute (such as Closed)*
Post-Replacement	S-Class A	
Mid-Development	S-Class C	S-Class B
Late-Development	S-Class D	S-Class E

Closed: A structural characteristic in which the upper layer of vegetation canopy is relatively closed. Default values for closed forest, woodland, or herbaceous classes are greater than 40 percent if based on canopy cover. Default values for closed shrub classes are greater than 15 percent if based on line intercept cover. These are commonly applied as structure attributes for succession classes B and E.

Coarse-scale FRCC map: General term referring to the initial FRCC modeling and mapping work of Schmidt and others (2001), which yielded a 1-km pixel resolution map for the conterminous 48 states. Available at: www.fs.fed.us/fire/fuelman/

Composition. The species in an ecosystem and their abundances, often expressed as percent of area.

Cover: The percent of upper layer canopy density. Commonly based on canopy cover estimates for forest, woodland, and herbaceous types and line intercept estimates for shrub and grass types.

Condition class: In FRCC methodology, a synonym for one of the three fire regime condition classes: 1) <33 percent (low) departure from reference conditions, 2) 33-66 percent (moderate) departure, 1) >66 percent (high) departure.

Datum: In the field of surveying, a datum is any point, line, or surface used as a reference for a measurement of another quantity. Commonly used datums for referencing spatial data are North American Datum 1983 (NAD 83) and North American Datum 1927 (NAD 27)

Default reference condition characteristics: Derived from national, regional, or subregional modeling of BpS reference conditions using a box model framework within the Vegetation Dynamics Development Tool (VDDT) modeling software. These provide an average percentage estimate for up to 5 characteristic succession classes per BpS in addition to estimates of fire frequency and fire severity for the natural regime. These reference values are defaults in FRCC methodology and can be adjusted by the user according to local data.

Desired future conditions (DFC): A characterization of future conditions commonly designed as a goal for management that integrates ecological and social factors. It is not synonymous with fire regime condition class or the end state of succession for a BpS. Users should be aware that DFC is not necessarily synonymous with FRCC I because DFC is usually based on social and economic factors rather than on a single goal such as maintaining or restoring natural ecosystems.

Departure: The inverse of similarity. For the succession classes and fire frequency-severity variables, this is the percentage of difference between current and reference conditions (see "Similarity" for a comparison of difference).

Disturbance. Disruption of successional processes by fire, wind, flooding, insects, pathogens, and other change agents.

Ecosystem. An interacting unit of organisms and their environment with a set of characteristic structure, functions, and composition. Ecosystems can occur at multiple scales.

Early-seral, post-replacement: The BpS stage in which vegetation is in an early-successional (or young) stage. In forested and woodland biophysical settings, this type will typically have less than 10 percent tree canopy cover and less than 5 percent canopy cover in shrubland biophysical settings. Ages will vary greatly depending on individual biophysical settings. This is typically "Class A" in FRCC methodology (see also Seral).

Emulate, Mimic, Represent, or Simulate natural conditions and processes: Various terms to indicate the use of management activities (such as timber harvest, thinning, grazing, prescribed fire, restoration, and non-suppression of wildland fire) to change landscape composition and associated disturbance regimes to more closely reflect natural reference conditions.

Fire Effects Information System (FEIS): A database summarizing and synthesizing research about living organisms in the United States, including their biology, ecology, and relationship to fire. Available at: http://www.fs.fed.us/database/feis/

Fire frequency / Mean fire interval (MFI): In FRCC methodology, this is the average number of years between fires for representative stands (defined as *cluster scale* by Arno and Peterson 1983). This is a measure of central tendency (average) and will be estimated for both reference fire frequency (default values will be used if the user does not specify a value) and for current fire frequency. In FRCC methodology, frequency is years between all types of fires (replacement, surface, and mixed) that change the landscape mosaic of succession classes. A fire must affect 5 percent or more of the fire perimeter to be included.

Fire regime: In FRCC methodology, a five-group classification based on fire frequency and fire severity. Natural or historical fire regimes may differ from current fire regimes, as measured by FRCC departure metrics.

Fire Regime Condition Class (FRCC): A classification of the amount of departure of conditions at a given time period (such as current or future) from ecological reference conditions. Pre-settlement ecosystems are commonly used as a benchmark for reference conditions and include possible Native American influence in the natural fire regime. As described below, the FRCC system uses three condition classes to signify low, moderate, or high departure from the natural fire regimes and associated vegetation.

FRCC characteristics: A measure of departure from reference (pre-settlement or natural or historical) ecological conditions that typically result in alterations of native ecosystem components. These ecosystem components include attributes such as species composition, structural stage, stand age, canopy closure, and fuel loadings. One or more of the following activities may have caused departures: fire suppression, timber harvesting, livestock grazing, introduction and establishment of exotic plant species, introduced insects or diseases, or other management activities. There are three classes:

Class	Description
1	Less than 33 percent departure from the central tendency of the historical range of variation (HRV): Fire regimes are within the natural or historical range and risk of losing key ecosystem components is low. Vegetation attributes (composition and structure) are well intact and functioning.
2	33 to 66 percent departure: Fire regimes have been moderately altered. Risk of losing key ecosystem components is moderate. Fire frequencies may have departed by one or more return intervals (either increased or decreased). This departure may result in moderate changes in fire and vegetation attributes.
3	Greater than 66 percent departure: Fire regimes have been substantially altered. Risk of losing key ecosystem components is high. Fire frequencies may have departed by multiple return intervals. This may result in dramatic changes in fire size, fire intensity and severity, and landscape patterns. Vegetation attributes have been substantially altered.

FRCC Mapping Tool (FRCCMT): An ArcGIS-based application for spatially assessing FRCC and for assisting spatial prioritization, and planning. The Mapping Tool uses analysis methods similar to those used by the FRCC Standard Landscape Worksheet Method described below but cannot currently calculate departure for the fire regimes component of the FRCC algorithm.

FRCC Standard Landscape Worksheet Method: A standardized landscape assessment system designed to support fire, vegetation, and fuels management planning. This method describes reference landscape characteristics based on fire regimes and associated vegetation, which are then evaluated against current conditions to produce departure and FRCC ratings. FRCC assessments can be conducted for two scales: *landscape-level FRCC* for assessing departure from reference conditions at the landscape scale and *stand-level FRCC* for assessing FRCC in smaller areas in the context of landscape-level FRCC. The landscape-level FRCC method must be conducted first in order to generate context inputs for stand-level FRCC assessments.

Fire regime group: A categorization of historical fire regimes to describe the frequency and intensity of fires (based on Heinselman1973). The FRCC classification uses five fire regime groups:

Group	Frequency	Severity
I	0-35 years	Low / mixed
II	0-35 years	Replacement
III	35-200 years	Mixed / low
IV	35-200 years	Replacement
V	200+ years	Replacement / any severity

Fire severity: In FRCC methodology, this is the effect of fire in terms of upper layer canopy replacement. Replacement may or may not cause a lethal effect on the plants. For example, replacement fire in grassland simply removes the leaves, which usually resprout from the basal crown; whereas replacement fire in most conifers causes total tree mortality. Note that a fire must affect 5 percent or more of the fire perimeter to be included in the analysis.

Severity Class	Effects
No Fire Effects	< 5 percent replacement
Low	6-25 percent replacement
Mixed	26-75 percent replacement
Replacement	> 75 percent replacement

Function. Ecosystem processes, such as water and nutrient cycling, disturbance, and succession.

Geographic information system (GIS): A geographic information system consists of computer software, hardware, and peripherals that transform geographically referenced spatial data into information on the locations, spatial interactions, and geographic relationships of the fixed and dynamic entities that occupy space in the natural and built environments.

Historical conditions: See "Reference Conditions."

Historical range of variability (HRV): See "Natural Range of Variability."

Historical vegetation: The vegetation that developed during the pre- settlement era. Historical vegetation was a reflection of land potential and disturbance regime. Historical vegetation is used to define the reference conditions of FRCC and is essentially the same as the disturbance-constrained definition of potential natural vegetation. See also Natural range of variability and Reference conditions.

LANDFIRE: A five-year, multi-partner project producing consistent and comprehensive maps and data describing vegetation, wildland fuel, and fire regimes across the United States. It is a shared project between the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior. LANDFIRE data products include layers of vegetation composition and structure, surface and canopy fuel characteristics, and historical fire regimes. LANDFIRE National methodologies are science-based and include extensive field-referenced data. LANDFIRE data products are designed to facilitate national- and regional-level strategic planning and reporting of wildland fire management activities. Data products are created at a 30-meter grid spatial resolution raster data set. For more information, visit www.landfire.gov.

Late-seral: The stage in a BpS in which vegetation is in a late-successional (or mature) stage for a given succession path. Ages will vary greatly depending on individual biophysical settings. This stage is typically associated with succession classes D and E in FRCC methodology.

Low-severity fire: Any surface fire replacing less than 25 percent of the dominant upper canopy layer in a succession class; as a result, low-severity fires can open or maintain a given succession class.

Map or method consistency/accuracy: In FRCC, consistency is a measure of agreement between the departure measure and class assignment across different geographic areas given the same combinations of inputs. For FRCC, accuracy refers to the similarity between calculation inputs and actual field conditions.

Mid-seral: The stage in a BpS in which vegetation is in a mid-successional (or immature) stage for a given succession path. Ages will vary greatly depending on individual biophysical settings. This stage is typically associated with succession classes B and C in FRCC methodology (see also Seral).

Mixed-severity fire: A generally broad fire severity classification that refers to fire effects intermediate between the low severity and replacement severity ends of the fire regimes continuum. For FRCC purposes, mixed-severity fires refer to fires producing between 25 and 75 percent upper-layer replacement during a given event. Mixed-severity fires can open or maintain a succession class.

Mosaic fire: Generally refers to mixed-severity fires. However, the term can be problematic because other fire severity types can produce landscape mosaic patterns composed of a mix of burned and unburned patches. Accordingly, more-precise terms like low, mixed, or replacement fire may be better terms for describing fire regimes for multiple analysis scales.

National Fire Plan Operations and Reporting System (NFPORS): NFPORS is an interagency system designed for submission and reporting of accomplishments for work conducted under the National Fire Plan and other agency fuels and resource programs.

Natural conditions: See "Reference conditions."

Natural fire regime: The reference fire regime that is operating in the absence of modern human interference. Natural fire regimes can include anthropogenic influences, such as American Indian fire use, that may have contributed to the development of native species' fire adaptations.

Natural range of variability (NRV): The variability and central tendencies of biophysical, disturbance, and climatic systems, across landscapes and through time, in the absence of modern human interference. Natural disturbances include native anthropogenic influences that have contributed to development of native species adaptations and natural disturbance regimes. Both the terms *Natural range of variability* and *Historical range of variability* are in common use (Landres and others 1999) and are used to refer to a timeframe prior to Euro-American settlement. The critical items to include are the timeframe and the assumptions regarding disturbance. (See the "Reference Condition Concepts" section of Chapter 2 for a more complete discussion.) Because historical climate no longer exists, development of a "present natural range of variation" metric – for the era from the present projected 100-500 years into the future – may be warranted. Until this concept has been more fully developed and models built, however, relying on estimates from the historical period is appropriate. See also Historical range of variability and Present natural range of variability.

Open: A stand's structural trait describing a relatively sparsely occupied upper layer vegetation canopy. For FRCC purposes, the default canopy cover values for open forest, woodland, or herbaceous classes are less than 40 percent if based on canopy cover; default values for open shrub classes are less than 15 percent if based on line intercept cover. These are commonly applied as structure attributes for "open" succession classes C and D.

Patch: See "Stand"

Potential natural vegetation (PNV): The potential of a land area to support a specific type of natural vegetation. It refers to the composition of successional stages that would occur in the absence of modern human interference. This concept has been interpreted in two main ways: (1) succession proceeds to a climax state limited only by climatic constraints and (2) succession proceeds to a point where a disturbance (such as fire) limits further development. The former is used by the USDA Forest Service (Winthers and others 2005) and includes the potential vegetation type concept. Kuchler's (1964) Potential Natural Vegetation classification is one example of the latter, as is the historical climax plant community used by NRCS and Interior agencies (NRCS 2003). PNV is used in FRCC as a proxy to describe the environmental setting, and hence land capability, to generate a specific ecosystem.

Potential natural vegetation group (PNVG): A grouping of ecologically similar vegetation types modeled with characteristic disturbance inputs and used for FRCC assessments. In FRCC, this term has been replaced by the term biophysical setting (BpS). (See also Historical vegetation, PNV, and Reference condition model).

Potential vegetation type (PVT): The potential of a land area to support one or more climax plant associations using a climate-constrained rather than disturbance-constrained concept. PVT is based on identification of land that will support climax plant association indicator species. This plant association concept is based on the traditional Clementsian view of succession continuing to an end climax condition in the absence of disturbance. The plant association is typically named by the climax plant indicator species. This concept is most commonly used in the Northern Rockies. (Note that climate-constrained climax classifications are not used for FRCC assessments because both vegetation and fire regimes can vary widely within and between PVTs on a given landscape. See PNV above for a comparison with disturbance-constrained definitions).

Potential vegetation type group (PVTG): A grouping of PVTs for coarse-scale assessment.

Present natural range of variability (PNRV): The variability and central tendencies of biophysical, disturbance,

and climatic systems, across landscapes, projected from the present into the future, in the absence of modern human interference.
The concept therefore is predictive and somewhat speculative, but offers the advantage of a time frame with the current and predicted climate, rather than an historical climate that no longer exists. If used, the time frame must be specified and might be on the order of 100-500 years into the future. Until this concept has been more fully developed and models built, however, relying on a specified historical period (the method currently used to determine reference conditions in FRCC) is appropriate. See also Historical range of variability, Natural range of variability.

Project area or landscape: In FRCC methodology, an assessment area exhibiting an array of biophysical settings and their associated natural vegetation and disturbance patterns.

Reference conditions: An estimate of the central tendency of the range (HRV) of succession class composition, fire frequency, and fire severity for a biophysical unit within a landscape project area. Reference conditions are the basis for calculating the ecological departure used to determine FRCC. A time frame for this variation is always specified during the model development process. Reference conditions could also use the present natural range of variability (PNRV) for current or future conditions with the present or expected future climatic regime. Because data and models are generally lacking for this approach, however, most modelers continue to use HRV as defined for a specific pre-settlement period and associated climatic regime. PNRV offers the advantage of using the current or future climatic regime, but HRV will be used for the time being because it can be more easily characterized by studies of historical vegetation and disturbance.

Reference condition model: The box model of succession and disturbance pathways calibrated to characterize the range of variability (HRV or potentially PNRV) and central tendencies for reference conditions for a BpS. Reference condition models are used to determine the default reference values for reference percent composition of vegetation succession classes A through E and for fire frequency and severity in the FRCC methodology. Although these are provided as defaults at www.frcc.gov, users can also customize these values to better reflect local conditions using VDDT modeling with available local data.

Reference condition refinement: A consistent, systematic, ongoing process of refinement of the BpS classifications and associated reference conditions. Area vegetation and fire ecology experts gather to participate in an initial workshop, review literature and area data, develop written descriptions of the BpS classes and disturbance regimes, test attributes and sensitivity using the "box model," conduct informal peer reviews and reach consensus, and revise the reference conditions. As described in Chapter 2, the default reference condition model creation and refinement process occurred during three stages: 1) creation of the original FRCC Guidebook models between 2003 and 2005, 2) refinement during the LANDFIRE Rapid Assessment (2004-2005), and 3) final refinement during the current LANDFIRE National mapping phase (2005-2009).

Reference condition state and transition model: See Box model.

Relative amount class: Succession class relative amount is the amount of a current S-Class compared to the estimated average amount for the reference period. The result is then classified into one of four categories: Trace, Under-Represented, Similar, Over-Represented, or Abundant.

Replacement-severity fire: Any fire that causes greater than 75 percent removal of the dominant upper canopy layer, reverting that succession class to an early-seral class. Note that such fires may or may not cause a lethal effect on the dominant plants. For example, replacement fire in grassland removes the leaves but leaves resprout from the basal crown, whereas replacement fire in most conifers causes mortality of the plant.

Seral (or Seral stage): A hypothesized step-wise process of vegetative succession that proceeds from an initial post-replacement disturbance state to later successional states (see also Succession).

Scale: As used in landscape ecology, scale refers to the spatial or temporal dimension of an object or process; it is characterized by both grain (finest level of spatial resolution) and extent (size of study area or duration of time under consideration). As used in cartography, scale is the degree of spatial reduction; it is the ratio of the distance on a map to the distance on the earth's surface. In a landscape assessment context, it is best to refer to scale in terms of extent ("broad" versus "local").

Similarity: In FRCC methodology, time period conditions (current or future) across a landscape are compared to a central tendency estimate for the natural or historical reference conditions of the BpS. In FRCC, this is determined for succession class composition across the landscape and for changes in fire frequency and fire severity. The method used to determine succession class composition similarity was developed by Clements (1934) and is a relatively simple formula that can be hand calculated in the field. The method used to determine fire frequency and severity similarity is a simple ratio of the smallest to the largest (Mueller-Dombois and Ellenberg 1974) that can also be hand calculated. (See Departure for comparison of difference).

Small area: See Stand.

Stand: For FRCC purposes, a stand is a small unit of relatively homogenous vegetation in a given succession class, often ranging from as little as 1 hectare (2 acres) to 100 hectares (250 acres) in size. Although the term "stand" is usually associated with forest and woodland biophysical settings and "patch" is generally used for rangeland and grassland types, note that the term "stand" is used for both situations throughout this Guidebook.

Stand-level assessment: A method for assigning FRCC to a given stand, patch, or small area comprising a succession class based on the relative amount of that succession class on the landscape. Note, however, that an

FRCC assessment must first be performed for the entire surrounding landscape before attempting to assess individual stands.

Stratum (Strata): For FRCC assessments, a compartmentalization of a given landscape, generally based on the area's array of biophysical settings.

Succession: The progression of change in the composition, structure, and processes of a plant community through time.

Succession class (S-Class): In FRCC methodology, a seral stage classification based on descriptions of structure and composition, disturbance processes, and pattern. S-Classes are grouped into those that are characteristic of the natural or historical conditions and those that are uncharacteristic of these conditions.

State and transition model: See Box model.

Uncharacteristic: A vegetation succession class that did not occur historically in a given biophysical setting. Uncharacteristic succession classes can occur as a result of invasive plants or introduced diseases, timber or grazing management that doesn't emulate natural disturbances, severe soil disturbance, or effects from native insects or diseases that are beyond their historical ranges of influence.

VDDT or Vegetation Dynamics Development Tool: A public domain software program created by the company ESSA. This tool provides software for reference condition modeling and is available at: www.essa.com