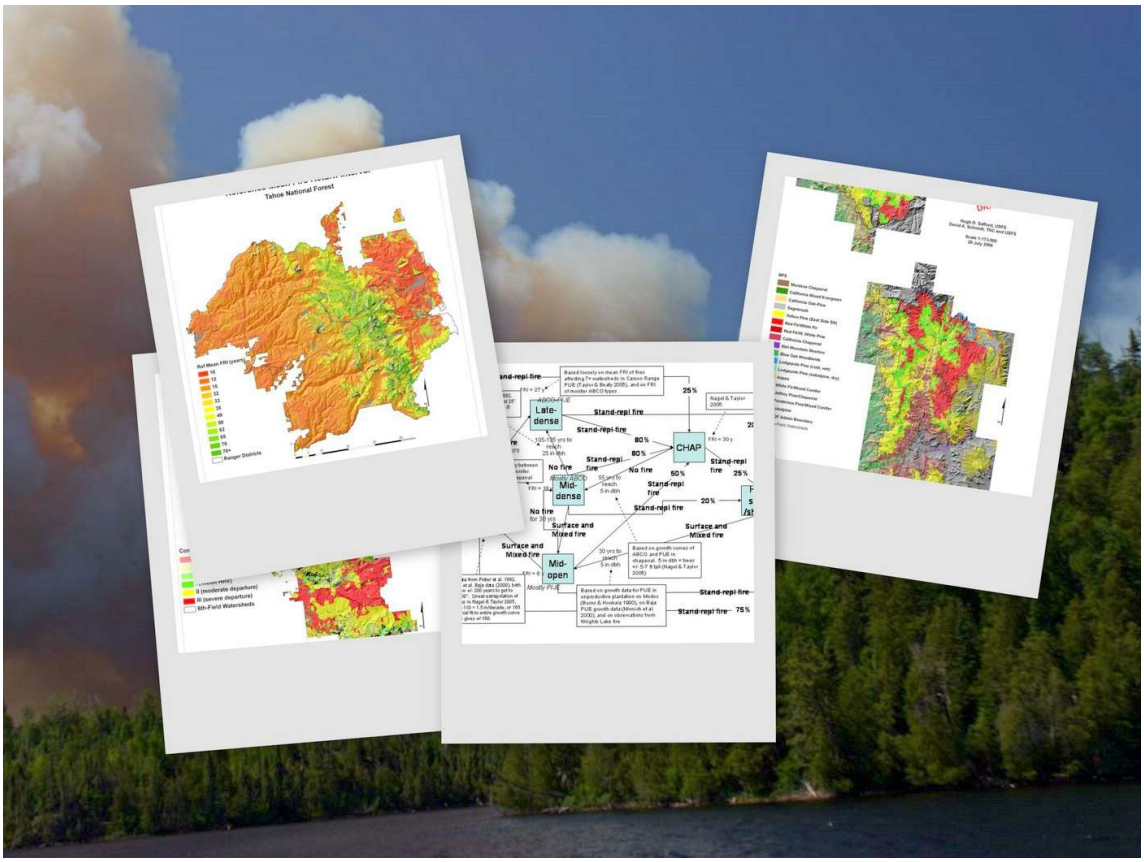
Fire Regime Condition Class (FRCC)

Version 1



Modoc National Forest

Regional Ecology Program, USDA-Forest Service Pacific Southwest Region
&
The Nature Conservancy, California Chapter

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Executive Summary

General: This document provides an overview of the results of our Version 1 fire regime and fire regime condition class (FRCC) mapping in the Modoc National Forest. The work was carried out by the Regional Ecology Program of the USDA-Forest Service Pacific Southwest Region, in concert with The Nature Conservancy, California Chapter. The information portrayed in these hard copy maps (and their GIS versions) was generated through a combination of literature research, expert input, spatial and statistical modeling, and first-hand data collection. The $FRCC_{(VS)}$ map on page 15 represents the standardized measure of FRCC developed by the national interagency FRCC and LANDFIRE groups. It is the same measure being mapped by LANDFIRE, but at higher resolution and using models which are both more realistic and more thoroughly validated. These maps provide a snapshot of the current state of the Modoc National Forest with respect to departures from historic fire regimes and vegetation structures, i.e., those conditions associated with pre-settlement times, when fire-resilient vegetation is assumed to have dominated the landscape. The information contained in this summary is current as of 2005 for fire perimeters, and 1999 for the base existing vegetation map (USFS-Remote Sensing Lab). This information should become integral to forest business, particularly Forest Planning, fuels treatment planning, postfire restoration work, and management response to fire. Frequent updates to these maps are planned as new information, mapping, and modeling results become available.

Executive Summary (cont.)

Specific: Mean historic (point) fire return intervals (FRI) on the Modoc National Forest ranged from >100 years to 10 years or less. About 50% of the landscape supported vegetation with point FRIs of 15 years or less. Today, fires are extremely uncommon on the forest, and current (1910-2005) fire return intervals are extremely long: 65% of the forest has not had a fire since 1910, and greater than 70% of the forest is characterized as moderately or severely departed (condition classes II and III) by the $FRCC_{(FRI)}$ measure (these are places where fire was common in pre-settlement times but has not occurred since 1910). On the other hand, many sagebrush-dominated areas south and west of Clear Lake are currently burning more frequently than they appear to have burned before settlement. By the $FRCC_{(VS)}$ (VS = Vegetation Structure) measure, which measures current departure from modeled pre-settlement distributions of seral stages (defined by overstory tree composition, canopy cover and diameter), about 63% of the forest is moderately or severely departed (condition classes II and III). By both condition class measures, most of the severely departed lands are found in areas which historically supported ponderosa pine/mixed conifer and yellow pine (ponderosa pine and/or Jeffrey pine) stands. Higher elevations areas (upper montane and subalpine conifers) appear to be mostly within historic ranges of variability for fire return intervals and seral stage distributions.

Introduction to Fire Regime Condition Class (FRCC), or "What FRCC Is (And Isn't)"

Background

"Condition Class" is simply a categorical measure of current departure from some idealized condition. In the federal land management agencies, especially in the West, the focus has been on current departures from fuels conditions that supposedly occurred under historic fire regimes, i.e., before the policies of fire suppression took effect in the first half of the 20th century. The general paradigm is that suppression of fires (and other human-caused changes, including grazing, timber removal, urban expansion, etc.) has led to an "unnatural" accumulation of fuels and biomass in much of the West, and therefore "unnaturally" severe fires, insect outbreaks, etc. This paradigm and its assumptions are valid in certain ecosystem types, and invalid in other ecosystem types. Either way, condition class should theoretically represent an easily understood classification of the magnitude of departure from these "historic" conditions.

There are many ways to calculate condition class, and different agencies and different units within agencies have been using widely disparate metrics. The interagency FRCC Program was created to develop a nationally standardized metric for assessing condition class. A draft national map of FRCC was created in 2000, and the interagency LANDFIRE Program is currently using the same process and metric to update this FRCC map at higher resolution across the United States. The purpose of this Introduction is to summarize the FRCC metric(s), and to provide some background vis-à-vis assumptions

behind these metrics, relative advantages and disadvantages of these metrics, and their proper and improper use.

FRCC

The national interagency FRCC program has developed condition class metrics for use at both landscape- and project-scales. The FRCC protocol (see http://www.frcc.gov) requires a preliminary estimate of condition class at the landscape scale before a local estimate may be made. The landscape-scale estimate is best made using mapped data and GIS. In USFS Region 5, landscape-scale FRCC determination and mapping is carried out by the Regional Ecology Program. National-level FRCC mapping is being carried out by the interagency LANDFIRE Program (http://www.landfire.gov). Although the interagency FRCC protocol recommends assessment of current departure from both historic fire regime characteristics (mean frequency and severity) and historic vegetation (floristics and structure), the LANDFIRE effort is producing FRCC maps based solely on the latter. This is due to the lack of reliable fire history data for most of the United States, and various difficulties associated with assessing historic and current fire severity. In Region 5, the Regional Ecology Program is collaborating with The Nature Conservancy to map FRCC based on departure from historic vegetation structure ("$FRCC_{(VS)}$") *and* historic fire frequency ("$FRCC_{(FRI)}$"), and we are currently working on a method to map departure from historic fire severity ("$FRCC_{(SEV)}$").

For more detailed information on each of the FRCC measures and their use, please consult the Map Descriptions and the remainder of this document. Below is an outline of some of the key features of each measure.

$FRCC_{(VS)}$ (departure from historic vegetation structure; this is the measure mapped by LANDFIRE)…

… is focused on restoration of vegetation structures characteristic of disturbance-resilient ecosystems
… incorporates information beyond fire effects (e.g., timber removal, insect, disease)
… is based on modeled reference conditions for historic vegetation floristics and structure ("BpS" models; see the Map Description)
... can provide broad acre targets for habitat restoration
… <u>is not a measure of fire behavior, severity, risk, or hazard</u>
… is not a measure of how well-protected communities, wildlife habitat, municipal watersheds, etc. are from fire
… is driven by the structure of overstory vegetation - this is due to the lack of understory information in most vegetation maps. As a result, <u>understory treatments such as surface-fuel and ladder-fuel removals often do not change $FRCC_{(VS)}$.</u>
…often requires significant change to overstory cover or size-class to change FRCC
… is pattern- and not process-based
… is watershed-dependent, i.e. the metric is computed at the level of the watershed (usually 6th or 7th field watersheds in California)
… is the only measure of FRCC mapped outside of Region 5

$FRCC_{(FRI)}$ (departure from historic fire frequency)…

… is process-based, and focuses on the role of fire in ecosystems (fuels reduction, nutrient cycling, hydrologic effects, habitat creation, seed scarification, etc.)

… only includes wildfires, not prescribed fires
… is not watershed-dependent
… is currently only mapped in Region 5

$FRCC_{(SEV)}$ (departure from historic fire severity; still in development)…

… is focused on fire behavior, risk, and hazard
… has a direct link to the purpose and nature of fuel treatments
… allows a logical link between local and landscape scales
… links surface fuel models and canopy torching index to Successional-Classes in BpS models
… is pattern- and process-based
… is watershed-dependent, i.e. like $FRCC_{(VS)}$ it is computed at the level of the watershed
… is currently in development in Region 5

Map Descriptions

Map 1. Biophysical Setting (page 10):
Biophysical settings (BpS) are the foundation of the FRCC mapping and modeling process. Each BpS represents the historic disturbance regime (including fire, insect and disease) for a given part of a landscape. A BpS map is an hypothesis as to the pre-settlement distribution of these different disturbance regimes, and is developed using a variety of resources, including Potential Natural Vegetation maps, Existing Vegetation Maps, gradient modeling of species distributions, Digital Elevation Models, and an understanding of the relationships between disturbance regimes and geography. Biophysical Settings are usually named after the dominant vegetation type which would exist under the disturbance regime in question ("Ponderosa pine", "Red fir/White fir"); the BpS map is thus a sort of "presettlement vegetation" map. Associated with each BpS is a "state-and-transition" model of the relationships between different successional classes ("S-classes", also known as "seral stages") under historic conditions. These S-classes are linked by growth, disturbance, and other ecological processes into a functional model of successional dynamics that may be applied to a specific part of the landscape. The BpS models are built and validated using information available from agency sources, scientific literature, expert opinion, and unpublished field data. BpS model outputs provide us with reference conditions that describe distributions of fire severities and fire return intervals and mean proportions of modeled landscapes in the different S-classes. These proportions can be compared to current conditions to develop measures of condition class (see Figure 1).

Note that the state-and-transition models built by the Region 5 Regional Ecology Program are significant "upgrades" from the models being used by the LANDFIRE group in their national scale mapping. For example, the Region 5 models integrate interannual climate variability (which is a key driver of fire effects), whereas the LANDFIRE models do not; the Region 5 models use "time-since-disturbance" (TSD) functions to allow fuels growth before a cell can burn, whereas the LANDFIRE models do not; the Region 5 models may include more than 5 states (S-classes) to allow for more realism in successional pathways, whereas LANDFIRE restricts its models to 5 or fewer states; the Region 5 models are also more rigorously validated.

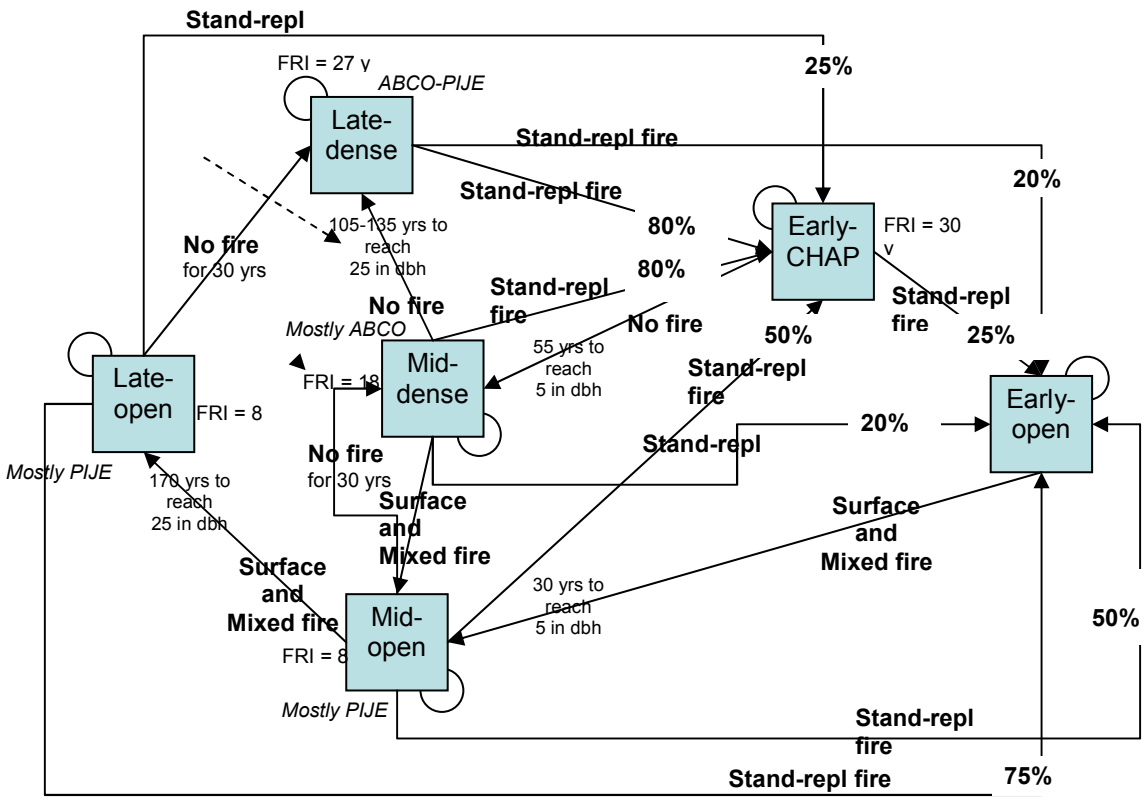


Figure 1. A simple state-and-transition model.

Succession Classes (map not shown)**:**
Succession classes ("S-classes") represent the building blocks of each BpS successional model. In the model above, each box represents an S-class. An S-class represents a stand of vegetation with defined characteristics in floristics and vegetation structure (e.g. canopy cover, size-class). Examples for a Ponderosa Pine BpS might be "Early Seral" (post-disturbance stands with trees <5" diameter, dominated often by herbs or shrubs), or "Late Seral Open" (stands dominated by pines >25" dbh with canopy cover <40%). Most BpS models have between 3 and 7 S-classes, but we standardize the number to 5 for spatial analysis with the FRCC Mapping Tool. S-class maps are derived by simple cross-walking from the best, most recent vegetation map of the analysis area, with updating where necessary.

Map 2. Reference Mean Fire Return Interval (Ref FRI) (page 11):
This map shows approximately how often, on average, a given BpS is thought to have burned in the presettlement era. These are mean values derived from published and unpublished studies of the presettlement fire record. These values are point return intervals (the mean values expected from analysis of single tree records) and are thus not susceptible to variability induced by different analysis areas. Some BpSs, such as Ponderosa Pine-Mixed Conifer, burned very frequently (mean point FRIs of ca. 10-12 years), while fire occurred only rarely in BpSs such as the Subalpine (mean point FRIs of more than 400 years).

Map 3. Number of Fires (page 12):
This map is derived from the CDF and USFS fire history database and show how often a given location has burned since 1910. Very small fires are not represented in this database.

Map 4. Current Mean Fire Return Interval (Current FRI) (page 13):
This map shows the geographic distribution of current fire return intervals for the analysis area. This is derived by taking the number of fires between 1910 and 2005 (i.e. the previous map) and dividing by the number of years (95).

Mean Fire Return Interval Departure (Mean FRID) (map not shown):
This map shows the departure of current mean FRI from reference mean FRI in percent. Unlike the FRID mapped by some National Parks, this metric does not reset the clock every time a fire occurs, i.e. it is based on the mean number of fires over the "current" period, i.e. 1910 to today.

Map 5. Fire Regime Condition Class based on mean FRID ($FRCC_{(FRI)}$) (page 14):
This FRCC measure is derived using the departure in the previous map. The following is employed for areas where the current FRI is longer than the reference FRI (the common condition in most of the coniferous West): {1 – (ref FRI/current FRI)}*100. The value obtained is a percent difference, and FRCC is determined using the national scale, i.e. 0-33% departure = CC1, 33-67% departure = CC2, and >67% = CC3. Where the current FRI is shorter than the reference FRI (e.g. some southern California chaparral, some WUI areas in the Sierra Nevada), the position of the two FRIs in the formula are switched. For these cases, we map "negative" condition classes (0 to -33% is CC-1, -33 to -67% is CC-2, etc.); these are places which are currently burning more often than under historic conditions.

Map 6. Fire Regime Condition Class based on departure from modeled vegetation structure under presettlement conditions ($FRCC_{(VS)}$) (page 15):
This map represents the national FRCC metric as developed by the interagency FRCC and LANDFIRE working groups. Blank areas in the map were not modeled, or they are occupied by vegetation types for which we have no mapped vegetation structure (e.g. shrub- and grasslands). The metric is a statistic calculated based on current departure from the predicted "historic" (presettlement) proportions of successional classes (see above) on a given landscape; these predicted presettlement values are one of the outputs of the BpS state-and-transition models. For most California BpS models, we are carrying out our analyses at subwatershed scales (7th field HUCs, or 2,000 to 7,000 acres), as most landscapes in California experienced relatively high frequency fires of relatively small sizes. For some BpSs (e.g. lodgepole pine in the Rockies), the appropriate spatial scale for analysis is much larger (3rd or 4th field HUCs, many 10,000's to 100,000's acres). The diagram below shows reference acres (from a state-and-transition model) and current acres (from the current veg map) for five successional classes, and the difference between the two, for the White Fir-Mixed Conifer BpS in a 7th field watershed on the Eldorado National Forest. The error bars in the reference values come from variability in the model outputs introduced by climate-driven variability in disturbance probabilities and

severities, the fact that each model is run many times using slightly varying inputs for growth rates and disturbances, and random variation inherent to any model based on statistical permutations. As in $FRCC_{(FRI)}$, a percent departure is calculated between (mean) reference and current, and each stand is given a condition class based on that % departure (0-33% = CC1, 33-67% = CC2, >67% = CC3). For the example below (see Figure 2), in areas of the watershed that have been assigned to the White Fir-Mixed Conifer BpS, early seral stands would be mapped as CC2 due to their 40% departure ([1-{459/771}]*100). Mid-open stands would be CC3, as they are 85% departed.

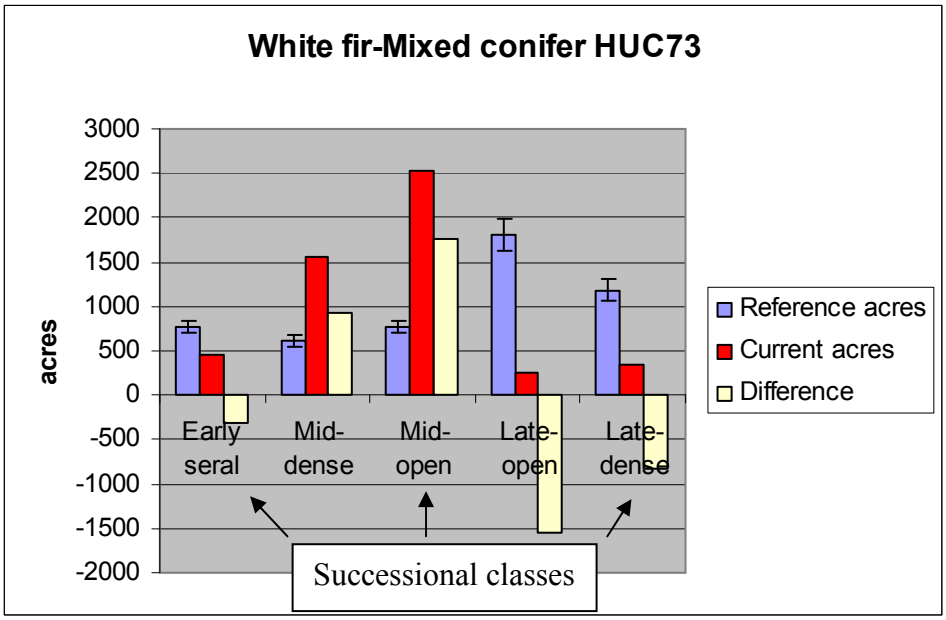
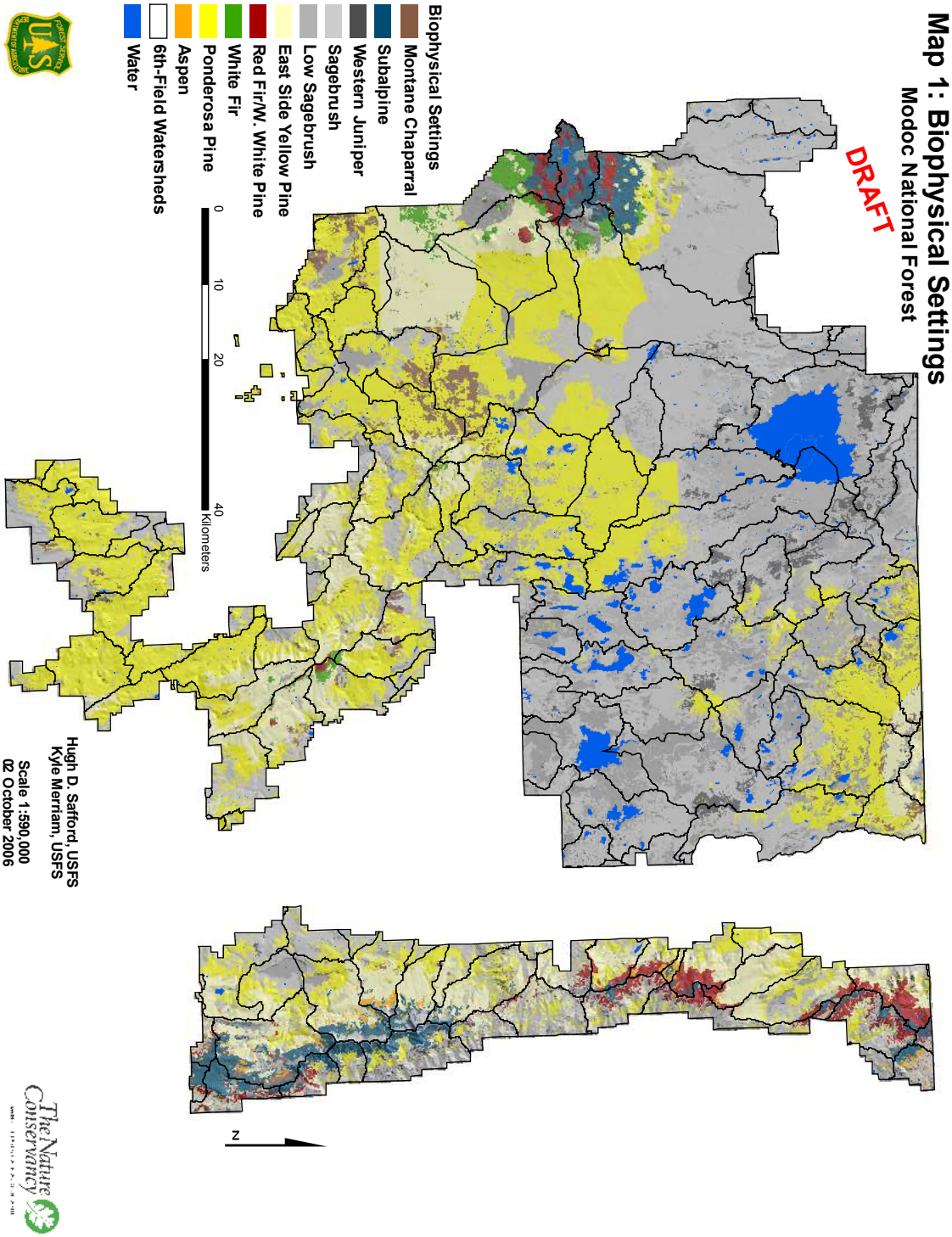


Figure 2. Current and reference acres, and departure for a BpS within an example watershed

Unlike $FRCC_{(FRI)}$, which only gauges fire frequency-related departures, departures measured by $FRCC_{(VS)}$ can be due to a theoretically limitless number of factors, including insect or disease mortality, timber extraction, urbanization, windthrow, fire, etc. In addition, $FRCC_{(VS)}$ is usually based on mapping products which include little or no information on shrub or herb layers within the analysis area. Interpretation of $FRCC_{(VS)}$ maps is a complicated endeavor and requires reference to information on BpS (veg type), successional classes, and site history, as well as an understanding of the underlying mapping limitations.

Succession Class Relative Amount (map not shown):
Unfortunately, the national methodology for FRCC can combine stands which are currently over-represented (e.g. Mid-dense and Mid-open in the diagram above), and stands which are under-represented (e.g. Late-open and Late-dense). For example, the Mid-dense successional class above is 60% <u>over</u>-represented currently (versus its mean historical representation for a watershed of this size), and Early-seral is 40% <u>under</u>-represented. The national FRCC metric places both of these into CC2 (33 to 67% departure), but this confounds two very different situations. The "Relative Amount" map

splits out the negative and positive departures (much as our $FRCC_{(FRI)}$ map does) and allows one to locate stands that are "too common" on landscapes versus those which are "too rare". Obviously, management concerns in these two situations are very different. In a Relative Amount map, highly-overrepresented stands are those that are >67% above the modeled historic mean, while over-represented stands are those that are 33-67% above the modeled mean. Stands within 33% of the mean (either positive or negative) are called "within historic range of variability"; "under-represented" stands are 33-67% less common than our model suggests they would have been historically, and highly-underrepresented are >67% less common.


Map 1: Biophysical Settings
Modoc National Forest
DRAFT
Biophysical Settings
Montane Chaparral
Subalpine
Western Juniper
Sagebrush
Low Sagebrush
East Side Yellow Pine
Red Fir/W. White Pine
White Fir
Ponderosa Pine
Aspen
6th-Field Watersheds
Water
0
10
20
40
Kilometers
N
Hugh D. Safford, USFS
Kyle Merriam, USFS
Scale 1:590,000
02 October 2006
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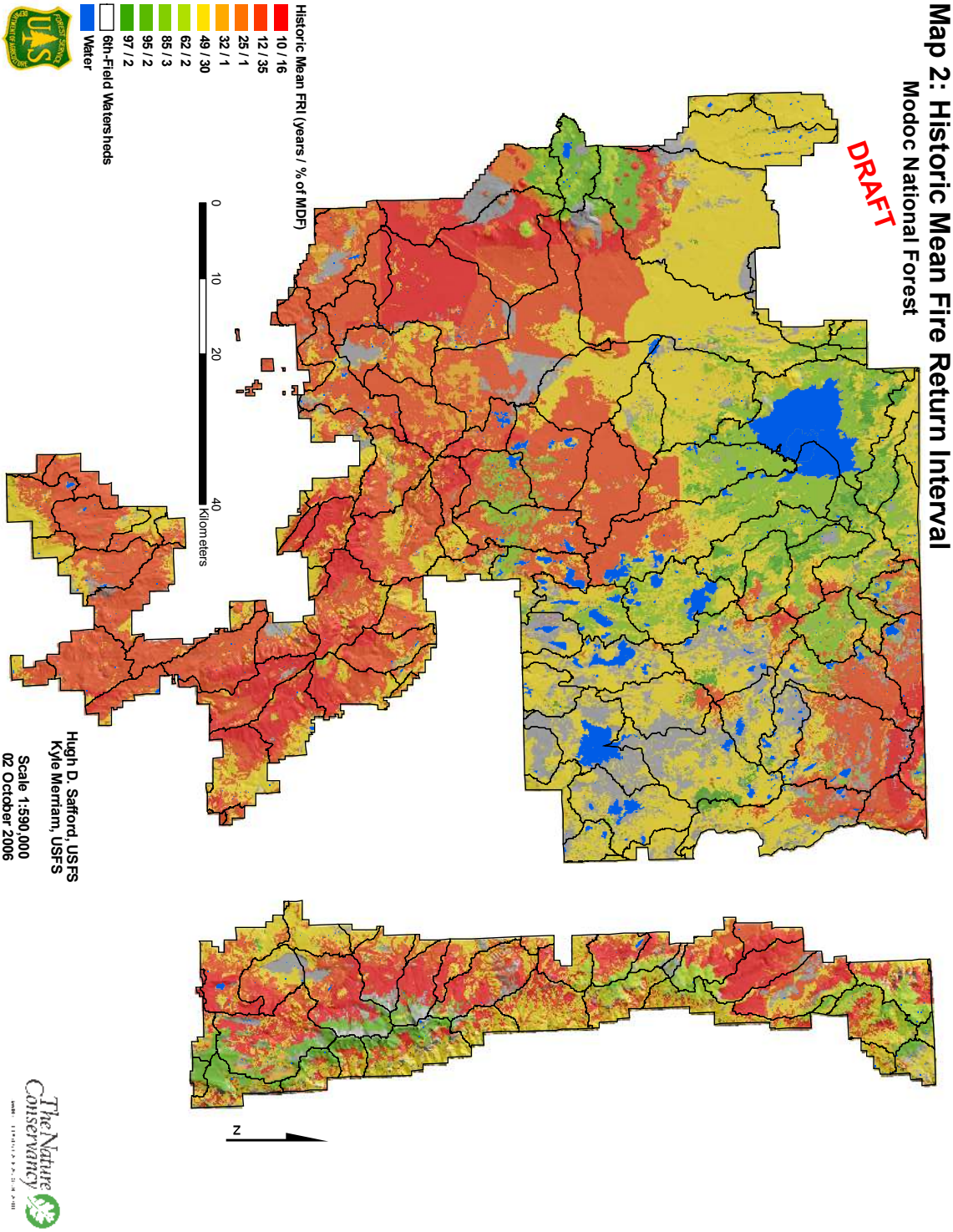
Map 2: Historic Mean Fire Return Interval
Modoc National Forest
DRAFT
Historic Mean FRI (years / % of MDF)
10 / 16
12 / 35
25 / 1
32 / 1
49 / 30
62 / 2
85 / 3
95 / 2
97 / 2
6th-Field Watersheds
Water
0
10
20
40
Kilometers
Hugh D. Safford, USFS
Kyle Merriam, USFS
Scale 1:590,000
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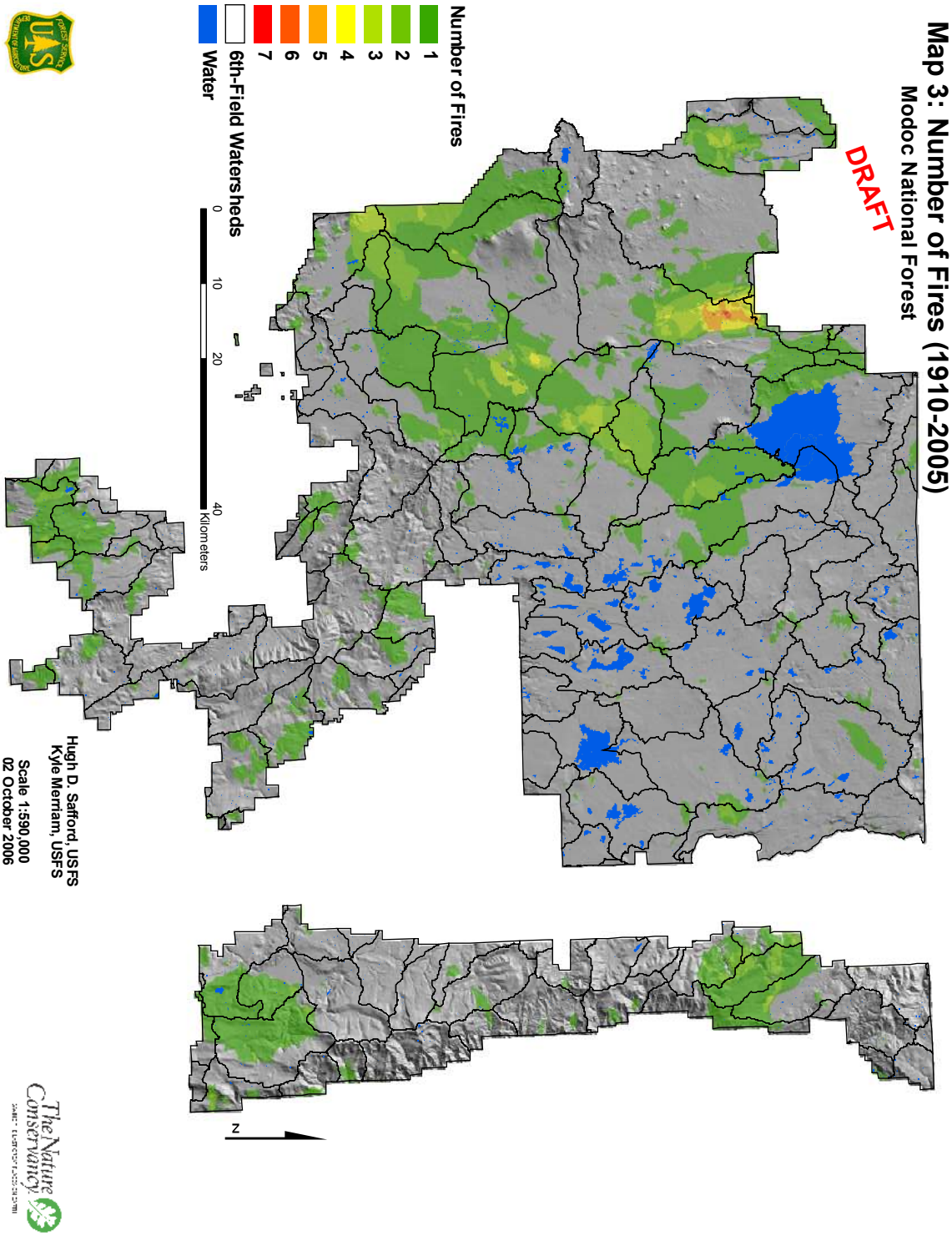
Map 3: Number of Fires (1910-2005)
Modoc National Forest
DRAFT
Number of Fires
1
2
3
4
5
6
7
6th-Field Watersheds
Water
0
10
20
40
Kilometers
N
Hugh D. Safford, USFS
Kyle Merriam, USFS
Scale 1:590,000
02 October 2006
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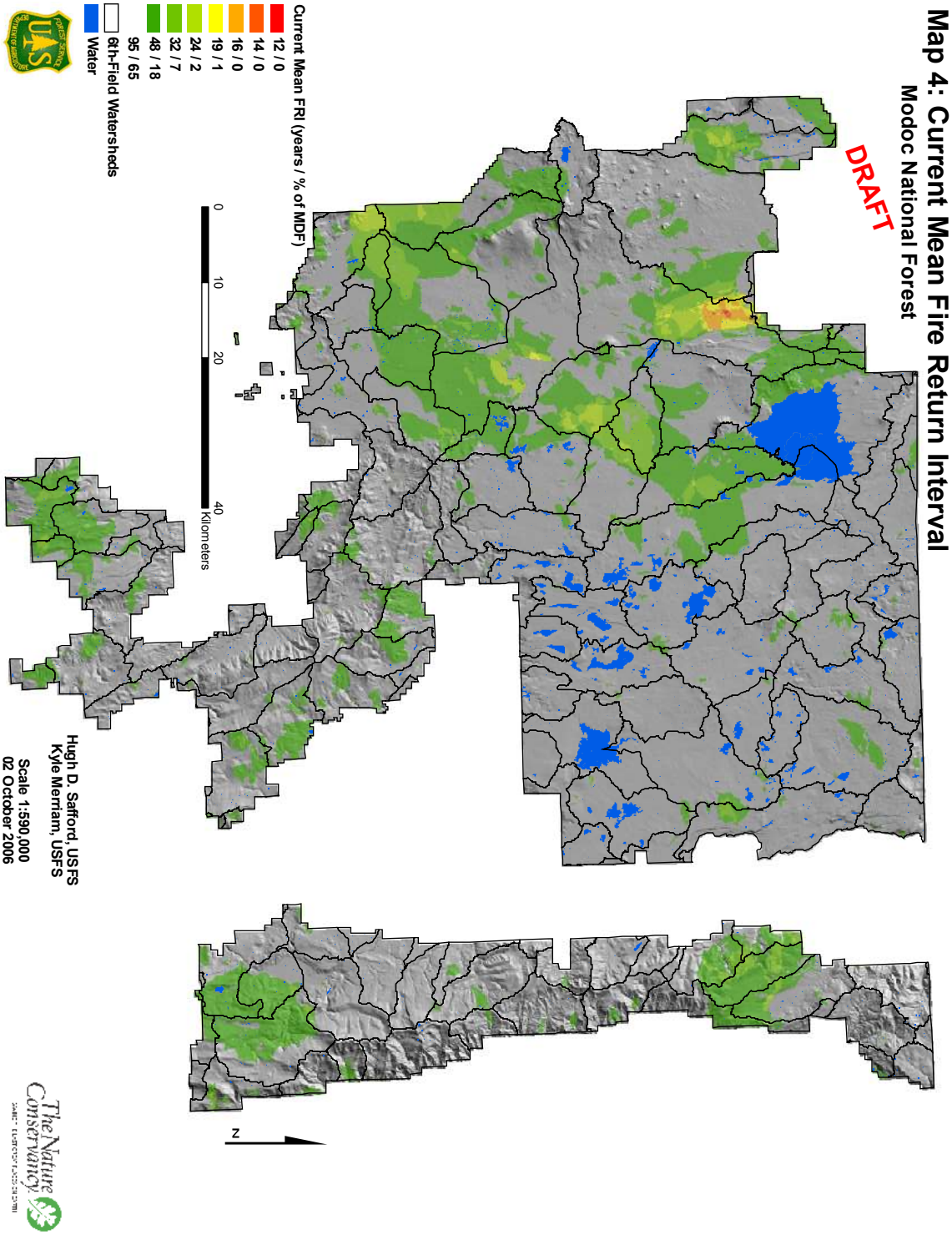
Map 4: Current Mean Fire Return Interval
Modoc National Forest
DRAFT
Current Mean FRI (years / % of MDF)
12 / 0
14 / 0
16 / 0
19 / 1
24 / 2
32 / 7
48 / 18
95 / 65
6th-Field Watersheds
Water
0
10
20
40
Kilometers
Hugh D. Safford, USFS
Kyle Merriam, USFS
Scale 1:590,000
02 October 2006
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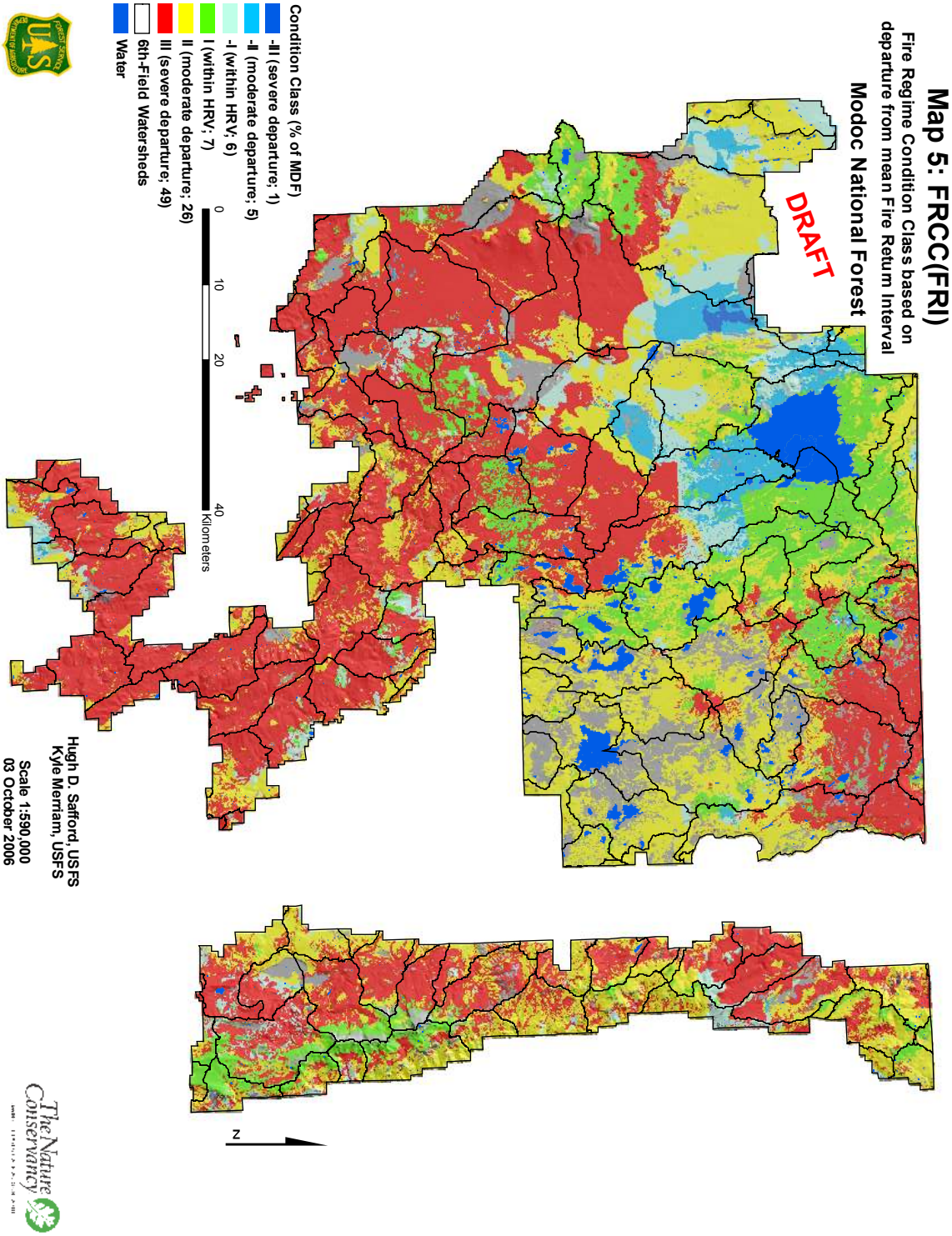
Map 5: FRCC(FRI)
Fire Regime Condition Class based on departure from mean Fire Return Interval
Modoc National Forest
DRAFT
Condition Class (% of MDF)
-III (severe departure; 1)
-II (moderate departure; 5)
-I (within HRV; 6)
I (within HRV; 7)
II (moderate departure; 26)
III (severe departure; 49)
6th-Field Watersheds
Water
0
10
20
40
Kilometers
N
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Kyle Merriam, USFS
Scale 1:590,000
03 October 2006
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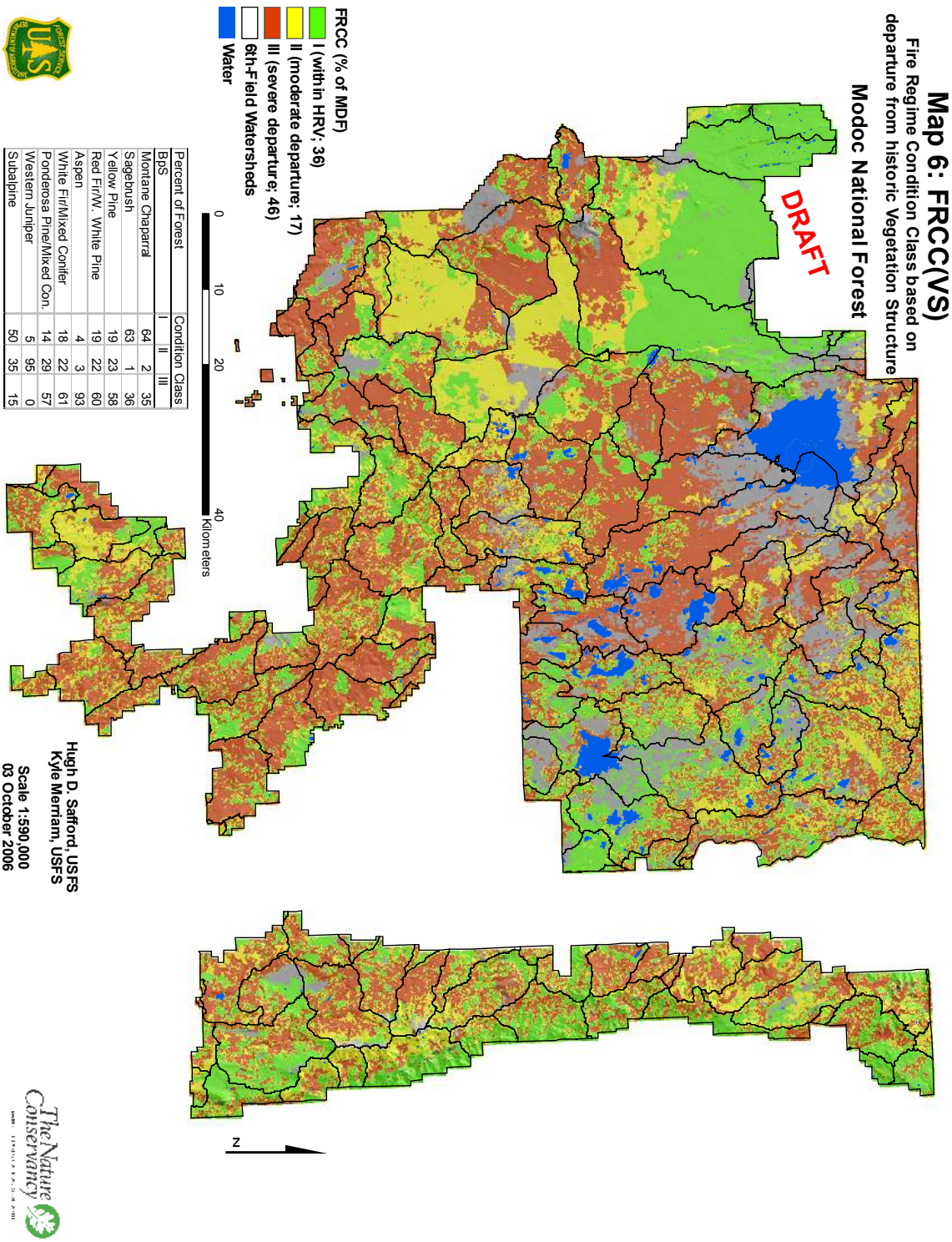

Percent of Forest	Condition Class		
BpS	I	II	III
Montane Chaparral	64	2	35
Sagebrush	63	1	36
Yellow Pine	19	23	58
Red Fir/W. White Pine	19	22	60
Aspen	4	3	93
White Fir/Mixed Conifer	18	22	61
Ponderosa Pine/Mixed Con.	14	29	57
Western Juniper	5	95	0
Subalpine	50	35	15

Development of historic reference conditions and applications in planning and restoration
7-27-2006

In USFS Region 5, we have recognized the need to integrate broader scales of time and space into our planning and implementation efforts in fuels and wildland fire activities. The "Fireshed Assessment" process was developed in R5 in order to provide National Forests with a suite of skills that could be used to strategically plan and schedule fuels treatments and other activities at the landscape scale. Because condition class has been identified as a key performance measure for USFS units, we added the suite of tools being developed by the interagency FRCC program (in conjunction with LANDFIRE and The Nature Conservancy) to the Fireshed process in late 2004. The FRCC process (FRCC 2005) involves the use of state-and-transition ("S&T") models of historic disturbance regimes to generate reference conditions which may be compared to current conditions to derive measures of departure (including condition class). The process is based on successional stages, which form the "states" within the S&T models, and which are defined based on structural characteristics of the overstory vegetation. One of the outputs of an FRCC S&T model is a predicted distribution of these seral stages on a landscape under the assumption of historic, pre-fire suppression conditions. This distribution can be compared to the current distribution (derived from a vegetation map or from field estimates) and a departure statistic calculated. The original S&T models were necessarily simplistic; more recent modeling, carried out by the Region 5 Ecology Program and TNC, represents considerable improvement and includes increased model complexity, climate forcing, fuels growth, better documentation and validation, etc. Some models are data-rich and heavily validated, others are best described as educated guesses.

Although the FRCC process was originally developed to generate a simple categorical measure of condition class, we realized quickly within Fireshed that the FRCC process had great potential for the assessment of cumulative effects of fuels treatments and wildfires at the landscape scale. Over the course of the past year, we have developed new tools and analytical processes based on the FRCC groundwork to: (1) assess the impacts of wildfires - essentially large, unplanned fuels treatments - on seral stage distribution at the landscape scale, so as to guide postfire restoration efforts and future fuels planning; and to (2) predict landscape-scale impacts on forest structure of 5-year fuels treatment plans being developed for all R5 Forests. It has also become very clear to us and to others in the Region that this sort of historic reference condition information is invaluable for broad-scale planning efforts such as Landscape/Watershed Assessments and Forest Planning.

On the Eldorado National Forest, we are using reference conditions generated through S&T modeling to help guide postfire restoration efforts in watersheds affected by the Power Fire of 2004. We have used fire mortality mapping to update our seral stage maps of the 7th-field watersheds surrounding each fire, and then calculated pre- and postfire departures to gauge the nature of the impact of the fires on vegetation in each watershed. The information provided in these outputs is extremely valuable to management planning within the burned watersheds. Variability in the ecological effects of the Power Fire, stratified by fire-regime type, can be gauged at the scale of single and multiple watersheds. Broad acre targets for long-term ecological restoration of specific seral stages can actually be generated for each watershed (with the understanding that single watersheds could vary significantly at any given time from the broad landscape mean). Given that reference conditions generated by our S&T models theoretically approximate the average historic condition in the analyzed landscapes (i.e. in the pre fire-suppression era), these outputs can serve as guidelines for restoration of sustainable, fire-resilient vegetation conditions across the landscape, both within and beyond the fire perimeter. In the same vein, restoration of forest structure following these guidelines (in conjunction with the reintroduction of fire as an ecological process) should also restore those ecological conditions most conducive to healthy wildlife and plant communities, which evolved under a very different

disturbance regime than that which currently characterizes most of the land we manage. Our analysis allows the Power Fire to be viewed as a restoration opportunity, rather than as a calamity.

We are carrying out a similar analysis on the Lake Tahoe Basin (LTBMU), using a related process to predict the effects of planned fuels treatments on seral stage distribution at the watershed and Forest-wide scales. The LTBMU, like all Forests in R5, is presently completing a 5-year plan for fuels treatments. These treatments were planned using the Fireshed process, which utilizes a suite of modeling techniques (fire behavior, fire severity, wildlife habitat relations, watershed, economics, etc.) to gauge the impacts, costs, and benefits of different proposed actions across the landscape. We are using seral stage departures from reference conditions within 7th-field watersheds to assess the future effects of the proposed treatments on landscape-level vegetation structure and condition class. To do this we must be able to predict the effects of the planned treatments on overstory canopy-cover and size-class. Using a stratified assignment of the FIA plot grid as the raw data, we are using the Forest Vegetation Simulator (FVS) to treat and grow out areas of planned fuels activities. For every five-year interval, we update the LTBMU vegetation map by applying canopy cover and size-class changes as estimated by FVS, then we recalculate the departure from historic reference conditions. This provides the Forest with an estimate of the impacts of their planned fuels treatment projects at the landscape scale, five years (and more) into the future. We are thus able to provide an assessment of the ecological impact of each planned treatment in the context of the entire affected watershed. Most treatments were planned primarily to protect structures or to moderate extreme-fire behavior, so their effects on condition class, forest structure, wildlife habitat, etc., have not been well-judged. This analysis will fill that information gap, and allow for iterative modification of planned treatments to meet ecological (and other) needs where such modification is warranted and reasonable. In particular, assessing the planned treatments in the context of the broader landscape will allow for an ecological cost-benefit analysis of the effects of local treatment prescription and location on sustainable, disturbance-resilient vegetation conditions at the watershed scale.

S&T modeling and historic reference condition information is finding its way into the new round of Forest Planning, and into an increasing number of projects. The LTBMU has incorporated historic reference conditions and FRCC directly into Pathway 2007 planning, and we hope that the Modoc NF will follow suit in its own Forest Plan. The R5 Ecology Program and TNC have recently finished products for the Shasta-Trinity, Klamath, Six Rivers, Plumas and Eldorado National Forests, and draft products are also available for the Sequoia, Mendocino, Stanislaus, Tahoe and Modoc National Forests; modeling and mapping for the Inyo and Sierra National Forests are just beginning. We have also completed Fire Return Interval Departure maps (a related product) for most of the Region. Examples of other current applications of this reference condition information include: the Heavenly Valley Resort Expansion EIS on the LTBMU; Power and Fred's Fire restoration on the Eldorado NF (see above); the Sugar Hill vegetation treatment project on the Modoc NF; the Clavey River Watershed Assessment on the Stanislaus; and the Diamond Project on the Plumas NF. Discussions are also underway on use of these methodologies in Fisher habitat modeling in the southern Sierra Nevada.

Finally, we believe there is real potential in the use of these products with other Fireshed outputs and fire behavior modeling to provide guidance in both strategic and tactical fire management decision-making. Our maps can provide fire managers with information on the ecological status of lands being affected or likely to be affected by a fire, allowing real-time decision-making that not only has the potential to maximize the ecological benefits of fire, but also to save considerable amounts of money by permitting more rational deployments of fire-fighting resources.