SHORT COMMUNICATION

COMPARING LOCALLY DERIVED AND LANDFIRE GEO-LAYERS IN THE GREAT BASIN, USA

Louis Provencher*[,1], Kori Blankenship[2], Jim Smith[3], Jeff Campbell[4], and Mike Polly[1]

[1]The Nature Conservancy,
1 East First Street, Suite 1007, Reno, Nevada 89509, USA

[2]The Nature Conservancy,
1575 NW Elgin Avenue, Bend, Oregon 97701, USA

[3]The Nature Conservancy,
1822 Swiss Oaks Street, Jacksonville, Florida 32259, USA

[4]Spatial Solutions, Inc.,
60575 Billadeau Road, Bend, Oregon 97702, USA

*Corresponding author: Tel.: 001-775-322-4990 ext. 20; e-mail: lprovencher@tnc.org

ABSTRACT

Locally derived maps of pre-European settlement vegetation patterns (Biophysical Setting-BpS) and Fire Regime Condition Class (FRCC) were compared to concomitant products from LANDFIRE for the Wassuk Range in western Nevada, USA. While Biophysical Settings between the two sources matched approximately half of the time, only 2.5 % of the area matched both FRCC and BpS simultaneously. The poor FRCC performance is largely due to undetected and extensive cheatgrass (*Bromus tectorum* L.) cover, overestimation of perennial native grass in extensive shrublands, and mapping confusion between true pinyon-juniper woodlands and areas where trees have encroached into native shrublands. LANDFIRE National products should be useful to resource-limited managers where sufficient training plots were available to the project, but we include practical guidance for using LANDFIRE spatial products in areas where the LANDFIRE project had insufficient ground plot information.

Keywords: FRCC, LANDFIRE, pre-European settlement vegetation, Wassuk Range

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INTRODUCTION

LANDFIRE National (LFNA) is a national project that created 20+ spatial layers and a suite of state-and-transition vegetation models for the entire US (Rollins 2009). Although LFNA products were designed for national, regional, or very large landscape applications, it is anticipated that users at smaller project levels may turn to LFNA in the absence of useful local data. In particular, Fire Regime Condition Class (FRCC), a measure of vegetation departure from a reference condition (Hann *et al*. 2004), and Biophysical Setting (BpS), which depicts pre-European settlement vegetation pattern, could be of tremendous interest. It is important and relevant to potential users to determine how well these LFNA products represent the landscape. This study compared locally derived Fire Regime Condition Class (FRCC) and Biophysical Setting (BpS) with corresponding LFNA products on a project-sized landscape, Wassuk Range, Nevada, USA.

METHODS

Study Area

The Wassuk Range project area (141 000 ha; Figure 1) is representative of western Great Basin mountain ranges with clearly defined zonal vegetation types distributed from the alpine summit of Mount Grant to the saline valley bottoms. The Wassuk Range is managed by the US Department of the Interior Bureau of Land Management (68 %), the US Department of Defense Hawthorne Army Depot (14 %), the US Department of Agriculture Forest Service (10 %), and private interests (8 %). Shrublands dominate at lower and higher elevations, and woodlands occur at middle elevations. Vegetation is comprised predominantly of Bailey's greasewood (*Sarcobatus baileyi* Coville), big sagebrush (*Artemisia tridentata* Nutt.), low sagebrush (*A. arbuscula* Nutt.), mountain big sagebrush (*A. tridentata* Nutt. ssp. *vaseyana* [Rydb.] Beetle), pinyon (*Pinus monophylla* Torr. & Frém.)–juniper (*Juniperus osteosperma* [Torr.] Little) woodland, curlleaf mountain mahogany (*Cercocarpus ledifolius* Nutt. var. *intermontanus* N.H. Holgren) woodland, and aspen (*Populus tremuloides* Michx.).

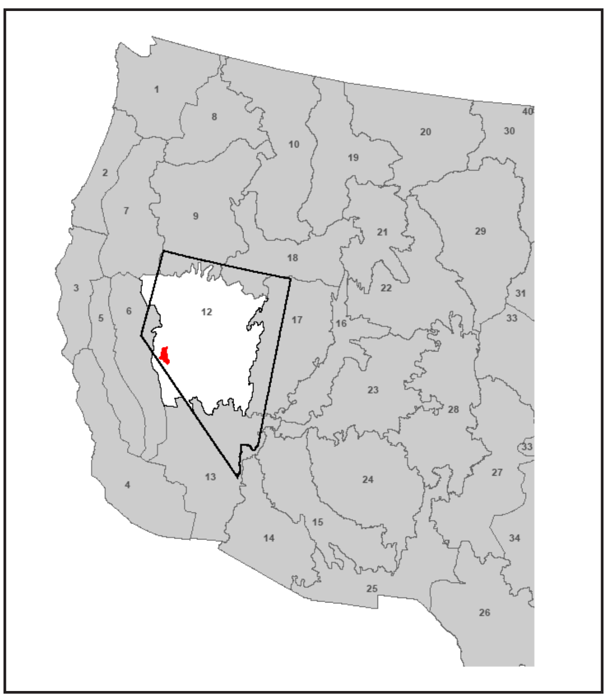

Figure 1. Wassuk Range LANDFIRE Application project in western Nevada.

LFNA Methods

The LANDFIRE project utilized LANDSAT Thematic Mapper imagery, the latest published mapping, and modeling techniques coupled with an extensive database of existing ground plots to create the BpS and FRCC spatial layers (see Rollins 2009 and www.landfire.gov for methodological details). Mapping product quality is typically very dependent upon the spatial and ecological distribution of the field information that drives the mapping processes. The Wassuk Range and surrounding areas had few plots in the LANDFIRE plot data base, potentially impacting the quality of the spatial products from project.

Local Data

The local team slightly modified the remote sensing and mapping methodology described by Provencher *et al.* (2008) for the

Mount Grant portion of the Wassuk Range. Differences between the steps used by Provencher *et al.* (2008) and this team were the result of a larger mapping area, availability of new software to calculate FRCC and associated products, quantitative vegetation models updated from LANDFIRE to calculate reference conditions, use of LANDSAT Thematic Mapper instead of higher resolution Ikonos imagery, and conducting FRCC mapping using a different landscape summary unit. Finally, not all steps used by Provencher *et al.* (2008) were needed for this project, such as the calculation of treatable areas. Briefly, local BpS was developed by interpreting Natural Resource Conservation Service (NRCS) soil surveys. Biophysical Settings were initially ascribed to LFNA types, but were later modified for local conditions. Current vegetation was mapped using July 2005 LANDSAT Thematic Mapper V imagery utilizing standard unsupervised classification methods. Image classification was supported by field visits to 68 training sites in the summer of 2006. Draft maps of BpS and current vegetation composition and structure (called "succession class" or "s-class" in LANDFIRE) were qualitatively verified and ultimately refined with an additional 94 plots in the field. This final s-class map was used to calculate the FRCC for the project area. Stratum-level FRCC was computed for the project area using the FRCC Map Tool (Hutter *et al.* 2007). Reference condition values were estimated from locally adjusted LFNA Vegetation Dynamics Development Tool models.

RESULTS

Biophysical Setting

Six Biophysical Settings represented 96% of the Wassuk Range according to the local map: pinyon-juniper woodland (34%), mixed salt desert scrub (19%), Wyoming big sagebrush-moist (13 %), low sagebrush (13%), Wyoming big sagebrush-dry (10%), and montane sagebrush steppe (6%). Approximately 49% of pixels identified to a BpS by the local project were also mapped as the same BpS by LFNA (Table 1). Data agreement varied by

Table 1. BpS confusion matrix for the 6 largest BpS. The percentage of matches as calculated by the diagonal for all BpS (not shown here) was 49%.

LANDFIRE National Biophysical Setting	Pinyon-juniper woodland	Mixed salt desert scrub	Wyoming big sagebrush (moist and dry)	Low sagebrush	Montane sagebrush steppe	Row total	Producer accuracy
Pinyon-juniper woodland	343 754	610	34 726	16 999	18 451	414 540	82.9%
Mixed salt desert scrub	11 170	210 657	100 111	12 697	291	334 926	62.9%
Wyoming big sagebrush (moist and wet)	61 654	34 027	113 492	60 432	29 267	298 872	38.0%
Low sagebrush	49 428	41 061	89 911	71 419	13 730	265 549	26.9%
Montane sagebrush steppe	38 059	3 041	16 897	18 880	21 296	98 173	21.7%
Column total	504 065	289 396	355 137	180 427	83 035	1 412 060	
User accuracy	68.2%	72.8%	32.0%	39.6%	25.6%	**Overall**	53.9%

BpS, with pinyon-juniper having the highest producer's accuracy and montane sagebrush steppe the lowest. In LFNA, pinyon-juniper woodlands (i.e. moist and dry) identified by the local project were most often mislabeled as Wyoming big sagebrush. Mixed salt desert scrub was most often labeled low sagebrush shrubland by LFNA. Wyoming big sagebrush was most often mislabeled as mixed salt desert scrub. Low sagebrush shrubland was mislabeled as Wyoming big sagebrush. Montane sagebrush steppe was mostly mislabeled as Wyoming big sagebrush.

Fire Regime Condition Class

The local project identified FRCC as 37% of pixels in class 1, 19% in class 2, and 43% in class 3 for the whole project area (Figure 2). LFNA's mapped 44% of pixels as class 1, 52% in class 2, and 3% in class 3 (Figure 3).

Biophysical Setting and Fire Regime Condition Class

Approximately 19% of pixels were assigned the same FRCC values by both the local project and LFNA for the whole project area (Table 2). In addition, it is important to determine when FRCC and BpS were jointly correct for a pixel because the FRCC value is not meaningful to managers if the underlying BpS was misidentified. At the whole project level, simultaneous FRCC and BpS agreement occurred on only 2.5% of the project area Table 3).

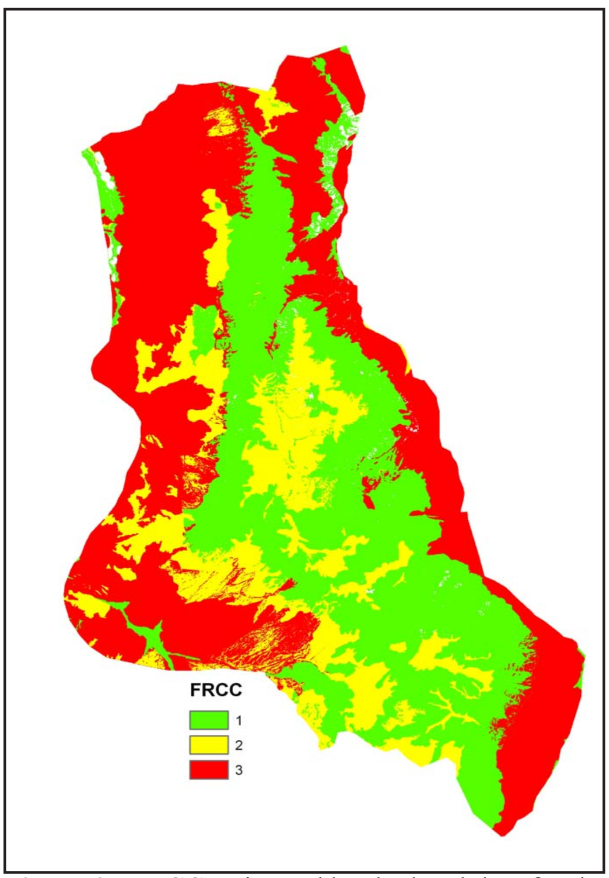

Figure 2. FRCC estimated by the local data for the Wassuk Range.

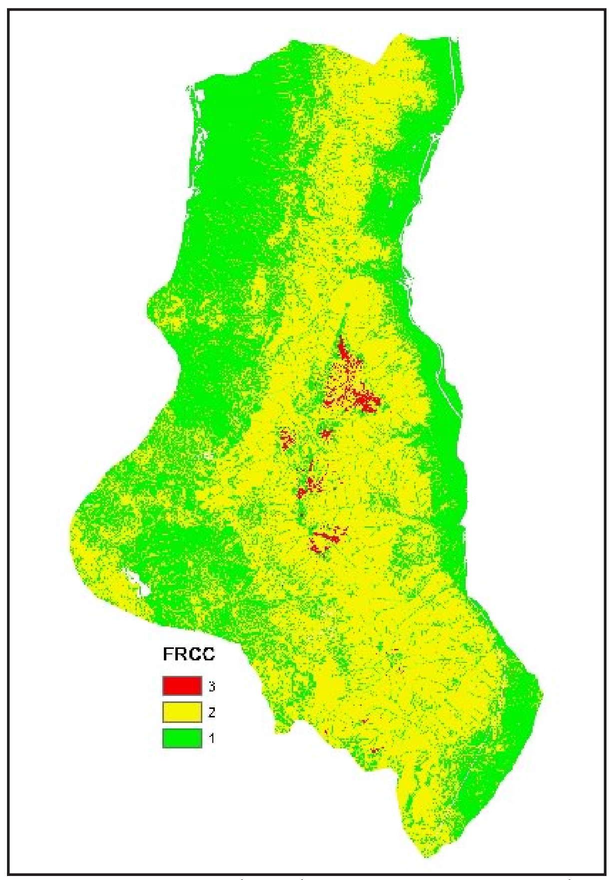

Figure 3. FRCC based on LANDFIRE geodata and estimated with the FRCC mapping tool for the Wassuk Range.

Table 2. Pixels in different FRCC classes identified by the local project and LFNA for the whole area.

	Local FRCC				
	1	2	3	No data*	Producer accuracy
LFNA					
1	110 242	107 296	457 711	7 633	16.1 %
2	462 186	179 538	201 104	2 568	21.2 %
3	2 671	9 329	10	88	0.1 %
No data	6 128	793	8 073	2 033	11.9 %
User accuracy	19.0 %	60.5 %	0.0 %	16.5 %	18.7 %

*No data included areas mapped as open water, barren-rock/sand/clay, barren/sparsely vegetated, roads/developed, and agriculture.

Table 3. Percent of study area where FRCC and BpS were both correctly mapped by LFNA. The total percent of matches is 2.54 for all BpS. (Not shown here.)

Biophysical Setting	Local FRCC	National FRCC	% pixels in common	% of study area
Pinyon-juniper woodland	none	none	0.00	0.00
Mixed salt desert scrub	none	none	0.00	0.00
Wyoming big sagebrush (dry and moist)	2	2	0.88	0.06
Low sagebrush	none	none	0.00	0.00
Montane sagebrush steppe	2	2	99.96	1.75

DISCUSSION

LANDFIRE data were designed for large scale analyses (Rollins 2009), and were not intended to replace local data where they are available and satisfactory. However, it is important to know how LANDFIRE products compare to locally derived data sets to help users apply LANDFIRE products appropriately. Overall, LFNA was moderately successful at mapping Biophysical Settings for the Wassuk Range area, but FRCC mapping success was low. The major reason for mismatches was that the local project relied on interpreted NRCS soil surveys to drive an intense mapping project that utilized remote sensing, a local team of experts, and three field visits to establish training plots and verification plots. LFNA was not able to use soil surveys, and geo-referenced field data were scarce for this region. Most errors for BpS mismatches were the result of pixels assigned to Biophysical Settings that were found at comparable elevations or in the next lower or upper vegetation zone. Because LFNA substantially depended on biophysical modeling to map Biophysical Settings but did not use the NRCS ecological site data layer because it is not nationally available, errors of this type are expected. This is especially true in Nevada where edaphic control of vegetation is strong and might override GIS elevation rules. For example, LFNA under-mapped true pinyon-juniper woodlands found on unproductive soils compared to the local project. For FRCC, the three greatest sources of error that explained the large differences in FRCC between the local project and LFNA were the detection of the annual non-native grass cheatgrass (*Bromus tectorum* L.), the detection of native perennial grasses, and variation in pinyon-juniper woodland cover. First, LFNA remote sensing specialists informed us that cheatgrass cover less than 10% could not be detected using LANDFIRE methods, whereas we frequently found and mapped cheatgrass cover as uncharacteristic vegetation between 5% to 10%. Second, LFNA greatly over-mapped mid-elevation shrublands as populated with perennial grasses between shrub canopies (i.e., characteristic vegetation classes), but the local project did not detect sufficient perennial grass cover that would be considered characteristic. These sources of error made the difference between FRCC 1 for the local project and FRCC 3 for LFNA, especially for the extensive big sagebrush shrublands. Third, discrepancies in mapping pinyon-juniper woodlands appear to have caused the local project to map these woodlands as FRCC 1, whereas LFNA mapped them as FRCC 2. Because this BpS is the most extensive in the project area, this difference is important and appeared to be explained by the large variation in canopy cover for older trees that the local project's field verification, but not LFNA's plot data, was able to integrate in its assessment.

Agency managers do not usually have the luxury to repeat the methodology reported here. The general guidance is that local mapping of FRCC following established mid-scale methodology (Shlisky and Hann 2003, Provencher *et al*. 2008) will generally be better than downloading LFNA geodata to remap FRCC for small project areas. If this is not possible, a good first step would be to ask LANDFIRE if sufficient geo-referenced plot data are available for remote sensing analysis in their area of interest. The general case for rangelands will likely be that too few plots are available when products were created; therefore, managers should use LFNA products only after a thorough review to ensure that the accuracy is sufficient for their application, or after improvements are made based on local data and knowledge. Assuming that managers wish to use LFNA FRCC, the first and most important step is to examine the credibility of the BpS raster file. In the easiest case, simple field surveys will convince managers that Biophysical Settings are adequately mapped and FRCC values recalculated with the FRCC Mapping Tool for the area of concern match local perceptions of ecological departure. Other, more involved options include improving the BpS map using existing local vegetation maps. Such improvement would require defining a careful crosswalk between current vegetation types and BpS that should result in GIS modifications to the BpS geodata. The validity of the crosswalk increases with the quality of the local existing vegetation map. The next step would be to similarly improve the s-class geodata, which is more difficult. In most cases, local existing vegetation maps lack information about succession and uncharacteristic classes within vegetation types. If s-class information is available, another careful crosswalk can be completed with GIS. If s-class information is lacking, users should download the most current s-class geodata from the LANDFIRE website and reclassify succession and uncharacteristic class geodata for the pixels for which Biophysical Settings were modified. Moreover, other geodata from independent sources (for example, a map of cheatgrass) might be used to improve the vegetation succession class map. The final step would be to recalculate the FRCC map. While we have found this process extremely valuable, none of these steps are trivial, and we recommend that land managers engage experts familiar with LANDFIRE methodology and ecological systems dynamics before attempting it.

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