Ecological Restoration Institute

SOUTHWEST FIRE SCIENCE CONSORTIUM

Fact Sheet: Methods for Estimating Surface Live Fuel Loading *February 2011*

Introduction

Resource managers often need data about surface live fuels (i.e., grasses, forbs, and shrubs) for a variety of purposes. For example, a range manager will want to know about grass biomass to gauge the amount of available forage for livestock. Likewise, a wildlife biologist may want to know about shrub biomass to determine the browse available for ungulates.

Fire managers also need to know about surface live fuels to understand potential fire behavior and fire effects of a site. Fire managers commonly need to assess several variables including fuel loading (another term for biomass), bulk density (weight per volume), and any inherent flammability that can be caused by plant oils and waxes. However, estimating these variables can be tricky and there are many different methods for doing so. Choosing the best method for a particular purpose depends on the level of accuracy needed, the resources available, and the level of knowledge in a particular region.

Methods

Methods for estimating surface live fuels can be described in three categories: 1) direct methods, 2) correlations or allometric equations, and 3) photo series or photo load series. Each method has certain advantages and disadvantages.

Direct Methods

Direct methods include any approach where grass, forb, or shrub biomass is assessed exactly and on-site. For grasses and forbs, this is often done by clipping the entire above-ground portions of these plants in a fixed area (often 0.5 x 0.5 m), drying the clippings in an oven until all the moisture is removed, and then weighing. This will give an estimation of fuel weight per area (biomass or loading). Estimated bulk density can be obtained by dividing the biomass by the average plant height. It is often more difficult to clip the entire above-ground portions of shrubs. Instead, a portion of the shrub can be clipped, dried, and weighed. Having made an estimate of the portion of the shrub taken, the fire manager can then multiple the weighed biomass by 100 to obtain the shrub's total biomass. The main advantage of using a direct method for estimating fuel loading is that it provides the most accurate estimate of fuel loading. However, direct methods are the most time consuming and labor intensive of all the methods—a significant disadvantage. Given enough resources, this method is most appropriate when there is no existing knowledge about fuels in a given area or more precise measures of fuel loading are needed.

Correlations and Allometric Equations/Modeling

Many correlations and allometric equations have been developed to estimate grass or shrub biomass without having to use direct methods. For many range systems, for example, there are regression equations that correlate grass biomass with cover and/or height. In forested systems, regression equations are available that correlate grass biomass with tree canopy cover or basal area. In shrublands, allometric equations relate shrub biomass to stem density and diameter. A main advantage of regression and

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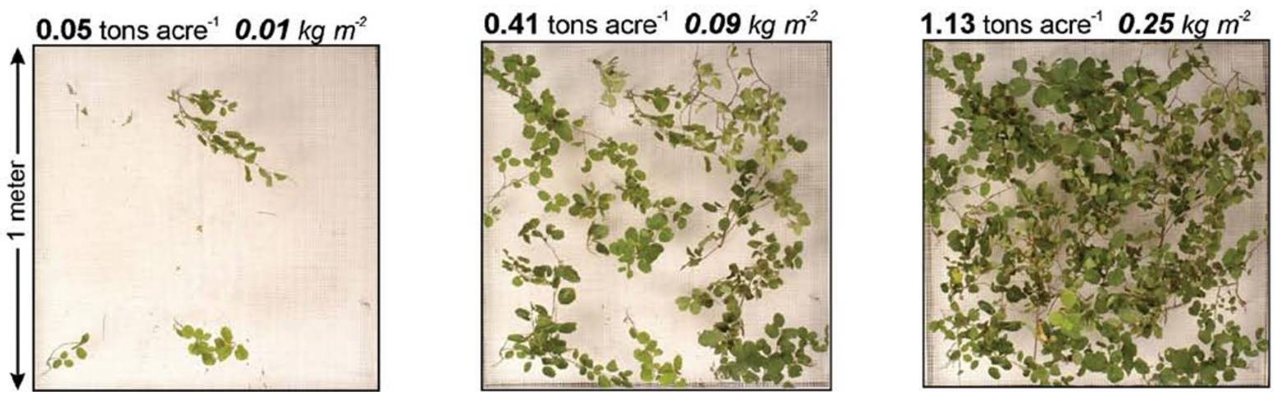
allometric equations is that they are not labor intensive and they can provide reasonably accurate estimates of live fuel biomass. The main disadvantage is that these types of equations are not always accurate. While the correlation between biomass and measured variables are strong in some instances, in other situations they are relatively weak. In addition, these types of equations are meant to be used in the specific locality and/or with the specific species for which they were developed. Allometric equations are not available for all shrub species and correlative equations are not available in all ecosystems that may be of interest.

Photo Series

A number of photo series have been developed for the purpose of making estimates of fuels. A photo series consists of several photographs taken of certain vegetation types. Photos are typically taken from a distance so that the viewer can see the entire fuel complex representative of a stand (e.g., surface to canopy). Associated with each photo in a series is a suite of data about fuel characteristics for that site, including fuel loading of various fuel types. Managers can estimate fuel loading in a given area by comparing it to photographs available in a photo series. If there is a photo that closely matches the given area, the accompanying data can provide reasonable estimates of various fuel characteristics. The photo load method is similar, except the photographs in a photo load series are taken at a smaller scale (often 1 x 1 m) and include artificial fuel beds with progressively higher fuel loading.



Example of photo load series from Keane and Dickinson (2007)

The main advantage of using photo series is that it is relatively easy to learn and doesn't require a great deal of investment in time or resources. A disadvantage of using photo series is that live surface fuels may not always be visible in the photographs. For this reason, using the photo load method may be more appropriate for live surface fuels. In addition, photo series are not available for all vegetation types and photo load series are not available for all plant species. Thus, this method is not available in all instances. Although, with the development of the fuel characteristic classification system and the digital photo series, the range of vegetation types with associated photo series has greatly expanded. It is important to note that even if a photo series is available for vegetation type of interest, it may not reflect the appropriate season or successional stage. Thus, it should always be used with caution.

Examples of photos taken from the Digital Photo Series

Conclusion

There are three basic methods available for estimating live fuel loading, and no one method is "best." The most appropriate method will be the one that meets a manager's needs. If more accuracy is needed and resources are available, then direct measures are best as is the case when a manager needs to develop a custom fuel model. Direct methods or equations may be appropriate if a manager wants to monitor the effects of fuel management activities on live surface fuels. In such cases, a more accurate estimation of fuel loading is needed. Photo series are most appropriate when the level of accuracy is lower. For example, precise estimates of live fuel loading are not necessary when a manager is trying to assign an existing fuel model to a particular stand. As is often the case, a land manager must determine the level of accuracy needed and the level of resources available before deciding which method to use.

Summary table

Method	**Advantage(s)**	**Disadvantage(s)**
Direct methods	Most accurate method	Time consuming and labor intensive
Correlative/ allometric equations	Can be accurate; relatively easy to use	Not always accurate; equations not available for all species and/or localities
Photo/photo load series	Easy to use; little expertise required	Provides only rough estimates; not available for all species and/or localities

Resources

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