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Average Biomass of Four Northwest Shrubs by Fuel Size Class and Crown Cover

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Abstract

The average biomass of big sagebrush (Artemisia tridentata Nutt.), antelope bitterbrush (Purshia tridentata (Pursh) DC.), snowbrush ceanothus (Ceanothus velutinus Dougl. ex Hook.), and greenleaf manzanita (Arctostaphylos patula Greene) was 6.1, 5.1, 10.7, and 16.2 tons per acre (13.9, 11.3, 24.0, and 36.0 tonnes per hectare (ha), respectively, for 100-percent shrub crown coverage. Biomass by fuel size class and category is tabulated for percent crown cover.

Keywords: Biomass, fuel loads, fire management, woody plants.

Introduction

Estimates or measurements of biomass and fuel loads for various forest and range situations are important to land managers. Comparisons of fuel loads and fire behavior are also important in the field of fire science. The data presented here were collected during several studies of forest and range burning to help estimate category and class of shrub fuel load. This paper provides information on the average biomass and fuel content of four shrub complexes. The data will be expanded as studies continue.

Methods

Data on shrub fuel loads of big sagebrush, antelope bitterbrush, snowbrush ceanothus and greenleaf manzanita were collected at several locations in Oregon and northern California east of the Cascade Range, specifically in the Pine Mountain, Kelsey Butte, and Pringle Falls areas of the Deschutes National Forest, the John Day River drainage of central Oregon, and Lava Beds National Monument in northern California.

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Shrubs dissected for the study were selected by the following procedure. Each area in which shrubs were collected was sampled at fixed points along lines run through sample areas, the distance between points varying according to size of the research area. At each point, 65.6-foot (20-meter (m)) transects were run at random angles. Along each transect, the second and eleventh shrubs whose crowns intersected the line were selected for sampling. The procedure varied in some cases because fuel complexes were quite varied; but choice of shrubs was systematic for each study.

The procedure described would bias the sample toward larger shrubs because larger crowns are more likely to be intersected than smaller crowns. Most shrubs on any given area, however, tended to fall in a narrow size range, thus reducing the actual bias toward larger shrubs.

Each shrub was described by species, number, and area and date of collection. Other data collected in the field for each shrub were:

- Average crown diameter (from largest and smallest diameter)
- Height (excluding flower stalks or occasional longer branches)
- Percent live crown surface
- Percent dead crown surface
- Age

Shrubs were then cut at groundline and placed in bags for return to the laboratory. Only one-quarter of very large shrubs was removed. The quarter selected was determined randomly.

In the laboratory, each shrub was separated into foliage and live and dead components by the following diameter size classes:

<u>Inches</u>	<u>Centimeters</u>	<u>Timelag fuel class, hours</u>
0-1/4	0-0.64	1
1/4-1	0.64-2.54	10
1-3	2.54-7.62	100
3	>7.62	1000

For convenience, all size classes, both live and dead, were documented by timelag fuel classes, even though timelag classes are regularly used only for dead stems. We feel this is useful in calculating fuels after burning, when most shrubs have been killed by fire. The fuel components were then oven-dried and weighed.

Data were compiled and manipulated on a desk-top calculator. Because size range of shrubs was small and the conditions and shapes of shrubs varied widely, regressions of fuel content versus size, age, and other characteristics were not strong. This situation may be corrected by sampling over a wider range of the independent variables in the future. Total fuel load per acre or hectare was then calculated from the fuel component loads in the average shrub of each species multiplied by the ratio of area per acre or hectare/area of average shrub.

Results

Shrub characteristics for the four species should be representative of average conditions over much of eastern Oregon and Washington and northern California without recent fire or other severe disturbance. Younger shrubs would have much smaller amounts of dead and large fuel than represented here. Small live fuels may make up crown cover percentages similar to those presented here, even though size of individual shrubs is quite different.

Bitterbrush is lowest in average fuel load and greenleaf manzanita the highest (table 1). To use the table, select the percent crown cover of a shrub species and read vertically to obtain fuel load by size class and live or dead category. Size classes are summarized for each category and total fuel load indicated. Table 2 can be used for size and percent live crown for shrubs near the sizes indicated.

The data in the table will be applicable to many areas in Oregon, Washington and northern California east of the Cascade Range. Because the data presented are averages, they must be applied with caution. We feel, however, that for 90 percent of the situations where no recent serious disturbance has occurred actual fuel loads will be between 50 and 200 percent of the indicated load. With the present state of predicting fire behavior, estimating fuel load from the table will probably be more accurate than other methods of prediction.

Shrub crown cover percent can be estimated or measured on an area of selected sample points by running transects from the points. By adding the distances the transect runs over shrub crowns and figuring these as a fraction of total transect length, the percent shrub crown cover can be calculated from:

$$\text{Shrub crown cover percent} = \frac{\text{shrub cover length}}{\text{total transect length}} \times 100.$$

Table 1-Average shrub fuel loads for live (L) and dead (D) categories by percent crown cover

Shrub timelag class	Percent cover									
	10	20	30	40	50	60	70	80	90	100
	Tons per acre (tonnes per hectare)									
	SNOWBRUSH/ CEANOTHUS									
Foliage	0.1(0.2)	0.1(0.3)	0.2(0.5)	0.3(0.6)	0.4(0.8)	0.4(1.0)	0.5(1.1)	0.6(1.3)	0.7(1.4)	0.7(1.6)
1 L	.1 (-3)	.2 (.5)	.3 (.8)	.5(1.0)	.6(1.3)	.7(1.5)	.8(1.8)	.9(2.0)	1.0(2.3)	1.1(2.5)
10 L	.2 (.4)	.3 (.8)	.5(1.1)	.7(1.5)	.9(1.9)	1.0(2.3)	1.2(2.7)	1.4(3.0)	1.6(3.4)	1.7(3.8)
100 L	--	--	--	--	--	--	--	--	--	--
1000 L	--	--	--	--	--	--	--	--	--	--
Live total	.4 (.9)	.6(1.6)	1.0(2.4)	1.5(3.1)	1.9(4.0)	2.1(4.8)	2.5(5.6)	2.9(6.3)	3.3(7.1)	3.5(7.9)
1 D	.4 (.9)	.8(1.8)	1.2(2.7)	1.6(3.6)	2.0(4.5)	2.4(5.4)	2.8(6.3)	3.2(7.2)	3.6(8.1)	4.0(9.0)
10 D	.3 (.7)	.6(1.4)	.9(2.1)	1.2(2.8)	1.5(3.5)	1.9(4.1)	2.2(4.8)	2.5(5.5)	2.8(6.2)	3.1(6.9)
100 D	--	--	(.1)	(.1)	.1 (.1)	.1 (.1)	.1 (.1)	.1 (.2)	.1 (.2)	.1 (.2)
1000 D	--	--	--	--	--	--	--	--	--	--
Dead total	.7(1.6)	1.4(3.2)	2.1(4.9)	2.8(6.5)	3.6(8.1)	4.4(9.6)	5.1(11.2)	5.8(12.9)	6.5(14.5)	7.2(16.1)
Grand total	1.1(2.5)	2.0(4.8)	3.1(7.3)	4.3(9.6)	5.5(12.1)	6.5(14.4)	7.6(16.8)	8.7(19.2)	9.8(21.6)	10.7(24.0)
	GREENLEAF MANZANITA									
Foliage	.1 (-2)	.2 (.4)	.3 (.7)	.4 (.9)	.5(1.1)	.6(1.3)	.7(1.5)	.8(1.8)	1.0(2.0)	1.0(2.2)
1 L	.1 (-2)	.2 (.4)	.3 (.7)	.4 (.9)	.5(1.1)	.6(1.3)	.7(1.5)	.8(1.8)	.9(2.0)	1.0(2.2)
10 L	.3 (.7)	.6(1.4)	.9(2.1)	1.2(2.8)	1.6(3.5)	1.9(4.1)	2.2(4.8)	2.5(5.5)	2.8(6.2)	3.1(6.9)
100 L	.2 (.5)	.4 (.9)	.6(1.4)	.8(1.8)	1.0(2.3)	1.2(2.7)	1.4(3.2)	1.6(3.6)	1.8(4.1)	2.0(4.5)
1000 L	--	(.1)	.1 (.1)	.1 (.2)	.1 (.2)	.1 (.2)	.1 (.3)	.2 (.3)	.2 (.4)	.2 (.4)
Live total	.7(1.6)	1.4(3.2)	2.2(5.0)	2.9(6.6)	3.7(8.2)	4.4(9.6)	5.1(11.3)	5.9(13.0)	6.7(14.7)	7.3(16.2)
1 D	.3 (.7)	.6(1.3)	.9(2.0)	1.2(2.7)	1.5(3.4)	1.8(4.0)	2.1(4.7)	2.4(5.4)	2.7(6.0)	3.0(6.7)
10 D	.4(1.0)	.9(2.0)	1.4(3.0)	1.8(4.0)	2.3(5.0)	2.7(6.0)	3.2(7.0)	3.6(8.0)	4.1(9.0)	4.5(10.0)
100 D	.1 (-3)	.3 (.6)	.4 (.9)	.6(1.2)	.7(1.6)	.8(1.9)	1.0(2.2)	1.1(2.5)	1.2(2.8)	1.4(3.1)
1000 D	--	--	--	--	--	--	--	--	--	--
Dead total	.8(2.0)	1.8(3.9)	2.7(5.9)	3.6(7.9)	4.5(10.0)	5.3(11.9)	6.3(13.9)	7.1(15.9)	8.0(17.8)	8.9(19.8)
Grand total	1.5(3.6)	3.2(7.1)	4.9(10.9)	6.5(14.5)	8.2(18.2)	9.7(21.5)	11.4(25.2)	13.0(28.9)	14.7(32.5)	16.2(36.0)

Table 1-Average shrub fuel loads for live (L) and dead (D) categories by percent crown cover (continued)

Shrub timelag class	Percent cover									
	10	20	30	40	50	60	70	80	90	100
	Tons per acre (tonnes per hectare)									
	BIG SAGEBRUSH									
Foliage	0.1(0.1)	0.1(0.3)	0.2(0.4)	0.2(0.6)	0.3(0.7)	0.4(0.8)	0.4(1.0)	0.5(1.1)	0.6(1.3)	0.6(1.4)
1 L	.1 (.2)	.2 (.3)	.2 (.5)	.3 (.7)	.4 (.9)	.5(1.0)	.5(1.2)	.6(1.4)	.7(1.5)	.8(1.7)
10 L	.1 (-3)	.2 (.5)	.4 (.8)	.5(1.1)	.6(1.4)	.7(1.6)	.8(1.9)	1.0(2.2)	1.1(2.4)	1.2(2.7)
100 L	.1 (.2)	.2 (.4)	.3 (.6)	.3 (.8)	.4(1.0)	.5(1.1)	.6(1.3)	.7(1.5)	.8(1.7)	.8(1.9)
1000 L	--	--	--	--	--	--	--	--	--	--
Live total	.4 (.8)	.7(1.5)	1.1(2.3)	1.3(3.2)	1.7(4.0)	2.1(4.5)	2.3(5.4)	2.8(6.2)	3.2(6.9)	3.4(7.7)
1 D	.2 (.4)	.3 (.7)	.5(1.1)	.6(1.4)	.8(1.8)	1.0(2.2)	1.1(2.5)	1.3(2.9)	1.5(3.2)	1.6(3.6)
10 D	.1 (.2)	.2 (.4)	.2 (.6)	.3 (.8)	.4(1.0)	.5(1.1)	.6(1.3)	.7(1.5)	.7(1.7)	.8(1.9)
100 D	- (.1)	- (.1)	.1 (.2)	.1 (.2)	.1 (-3)	.1 (.3)	.2 (.4)	.2 (.4)	.2 (.5)	.2 (.5)
1000 D	--	--	- (.1)	(.1)	(.1)	(.1)	.1 (.1)	.1 (.1)	.1 (.2)	.1 (.2)
Dead total	.3 (.7)	.5(1.2)	.8(2.0)	1.0(2.5)	1.3(3.2)	1.6(3.7)	2.0(4.3)	2.3(4.9)	2.5(5.6)	2.7(6.2)
Grand total	.7(1.5)	1.2(2.7)	1.9(4.3)	2.3(5.7)	3.0(7.2)	3.7(8.2)	4.3(9.7)	5.1(11.1)	5.7(12.5)	6.2(13.9)
	BITTERBRUSH									
Foliage	--	--	.1	(.1)	.1 (.1)	.1 (.1)	.1 (.1)	.1 (.2)	.1 (.2)	.1 (.2)
1 L	.1 (.2)	.2 (.4)	.2 (.5)	.3 (.7)	.4 (.9)	.5(1.1)	.6(1.3)	.6(1.4)	.7(1.6)	.8(1.8)
10 L	.1 (-1)	.1 (.2)	.2 (.3)	.2 (.4)	.3 (.6)	.3 (.7)	.4 (.8)	.4 (.9)	.5(1.0)	.5(1.1)
100 L	--	--	(.1)	(.1)	.1 (.1)	.1 (.1)	.1 (.1)	.1 (.2)	.1 (-2)	.1 (.2)
1000 L	--	--	--	--	--	--	--	--	--	--
Live total	.2 (.3)	.3 (.6)	.4(1.0)	.5(1.3)	.9(1.7)	1.0(2.0)	1.2(2.3)	1.2(2.7)	1.4(3.0)	1.5(3.3)
1 D	.2 (.5)	.4 (.9)	.6(1.4)	.8(1.8)	1.0(2.3)	1.2(2.7)	1.4(3.2)	1.6(3.6)	1.8(4.1)	2.0(4.5)
10 D	.2 (.3)	.3 (.6)	.4 (.9)	.6(1.2)	.7(1.6)	.8(1.9)	1.0(2.2)	1.1(2.5)	1.3(2.8)	1.4(3.1)
100 D	--	(.1)	.1 (.1)	.1 (.2)	.1 (.2)	.1 (.2)	.1 (-3)	.2 (.3)	.2 (.4)	.2 (.4)
1000 D	--	--	--	--	--	--	--	--	--	--
Dead total	.4 (.8)	.7(1.6)	1.1(2.4)	1.5(3.2)	1.8(4.1)	2.1(4.8)	2.5(5.7)	2.9(6.4)	3.3(7.3)	3.6 (8.0)
Grand total	.6(1.1)	1.0(2.2)	1.5(3.4)	2.0(4.5)	2.7(5.8)	3.1(6.8)	3.7(8.0)	4.1(9.1)	4.7(10.3)	5.1(11.3)

Table 2—Average and standard deviation for size and percent live crown of shrubs sampled

Species and measurements	Standard deviation		Standard deviation		Standard deviation	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
	-Centimeters-		-----Inches-----		-Percent live-	
Big sagebrush					60.1	27.2
Crown diam.	74.8	30.8	30.0	12.3		
Crown ht.	60.3	30.6	24.1	12.2		
Antelope bitterbrush					47.3	37.0
Crown diam.	64.5	33.7	25.8	13.5		
Crown ht.	40.6	20.7	16.3	8.3		
Snowbrush ceanothus					51.6	28.8
Crown diam.	129.0	71.8	51.6	28.7		
Crown ht.	72.9	47.1	29.2	18.8		
Greenleaf manzanita					52.3	28.3
Crown diam.	208.0	123.0	83.2	49.2		
Crown ht.	97.0	49.0	38.8	19.6		

Once the field person has measured several transects, he or she may become skilled enough in estimating percent shrub crown cover to require only occasional checks. The tables may also be used in conjunction with the natural fuel photo series such as Maxwell and Ward (1980) to obtain shrub crown cover and use this in the tables.

Summary

We have presented average biomass loads by percent of shrub crown cover for four northwest shrubs. These data can serve as an interim tool to estimate fuel loads by size class and category until more exacting data are compiled and analyzed. Current data provide a first estimate of shrub fuel loads for this area.

Literature Cited

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