Visual Fuel Load Guide
for the Swan Coastal Plain and Darling Scarp

Environmental Protection Branch
August 2015
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Introduction

Many factors influence fire behaviour but none is more significant than fuel. Fuel is the availability, size, arrangement, connectivity, moisture content and type of flammable material available. Understanding the different aspects of fuels can help predict the likelihood of fire and how a fire will behave under certain conditions, which can in turn help manage the risks and assess the best fire suppression options.

As a fuel load increases the potential run (fire spread) and heat output (fire intensity) increases, therefore increasing the risk to life, property, the environment and firefighter safety.

Purpose of this booklet

This booklet is designed as a reference guide to allow fire managers, natural resource managers, community members and local government to effectively assess the fire risk in relation to surface and near surface fine fuel loads on the land under their jurisdiction.

Swan Coastal Plain

The Swan Coastal Plain is defined as the land running parallel to the coast from Jurien Bay in the north, to Cape Naturaliste in the south (Figure 1). The Swan Coastal Plain is approximately 25–30 kilometres wide from the coast and bordered to the east by the Darling Scarp. It covers over 15,000 km² and contains a rich diversity of vegetation which, in many instances, is unique to Western Australia. Geomorphologically the Swan Coastal Plain forms a low-lying belt running parallel from the coast. Generally scrub and heath communities are found in the dune systems closer to the coast while seasonal and perennial wetlands are fringed with paper bark and sedge communities. Banksia woodlands and Eucalypt forests are common throughout other areas of the Swan Coastal Plain.¹

Most natural environments are susceptible to fire and this is especially true for this region due to the Mediterranean climate it experiences, that is hot dry summers with an extended annual drought and short mild winters where most rain falls between July and August.

¹ Department of the Environment. 2012. Interim Biogeographic Regionalisation for Australia (Regions) v. 7 (IBRA).
Methods of fuel sampling

The method used in this guide to calculate surface (leaves, twigs, bark and other fine fuel lying on the ground, predominantly horizontal in orientation) and near surface (live and dead fuel, including suspended leaves, bark or twigs, effectively in touch with the ground but not lying on it, with a mixture of vertical and horizontal orientation) fine fuel loads is based on a 1m² quadrat fuel sample. Sampling was undertaken at a subset of locations on the Swan Coastal Plain of Western Australia. These locations were chosen to ensure samples were taken across different vegetation and soil types. A one metre square area is marked over an area of vegetation considered representative of the vegetation community within the sample site. All dead vegetation from within the quadrat, which is less than 6 mm in diameter (dead material) and all live vegetation that is less than 3 mm in diameter is removed and oven dried to determine the dry weight of the sample. The dried weight of the vegetation is extrapolated to tonnes per hectare (t/ha). The one metre white square in the photos (shown overleaf) represents a typical quadrat sample area of vegetation at each sample site.

Fuel load calculation

Dried weight (grams per metre²) / 100 = fuel load (t/ha)
How to use this Guide

This guide is intended to assist the user in visually determining surface and near surface fuel loads. This guide is a non-destructive means of assessing surface and near surface fuel loads in that vegetation does not need to be removed in order to gain an estimation of the fuel load for a particular area. By visually assessing the vegetation with reference to this guide, and where possible obtaining a leaf litter depth (refer to Appendix 1), estimation of the surface and near surface fuel load of the represented vegetation can be made.

Where leaf litter is present, it must be measured and added to the scrub fuel load to obtain a total fuel load. The tables to convert the litter depth to tonnes per hectare are in the rear pages of this guide. The images depicted in this guide indicate only the level of scrub fuel unless otherwise stated. Where leaf litter is present, the additional fuel load is indicated in the text above the photo.

Limitations of this Guide

This guide only considers surface and near surface fuels and does not consider elevated or bark fuels. Near surface and surface fuels will burn in any ground fire, regardless of intensity and therefore are an important determinant of whether a fire will ignite and carry. Additionally, some fuel loads represented in this guide were taken out of the fire season and therefore the vegetation will appear greener than during the months of the fire season.
0–5 tonnes scrub per hectare

0.5 t/ha  Sparse pasture on degraded land with little overstorey.
0.9 t/ha  Mixture of scrub fuels and grasses. Leaf litter represents an additional 27.1 t/ha of fuel.
1.8 t/ha Grass fuel understorey. Leaf litter represents an additional 10.5 t/ha of fuel.
2 t/ha  Grass fuel under a sparse tree crown overstorey. The grass is relatively short.

October 2008
2.3 t/ha  Understorey of native sedges and shrubs.
2.4 t/ha  Seasonally inundated wetland with very light cover of native sedges.
2.7 t/ha  Scrub fuel load under a sparse overstorey. Leaf litter represents an additional 5 t/ha of fuel.
3.3 t/ha  Light understorey of introduced grasses and open vegetation with minimal overstorey.
4 t/ha  Light understorey of native sedges and grasses.
**4.2 t/ha**  Sparse understorey of introduced grasses and small native shrubs.
4.4 t/ha  Light understorey of native grasses. Leaf litter represents an additional 4.7 t/ha of fuel.

May 2011
4.9 t/ha  Sparse coastal shrub vegetation with no overstorey.
5–10 tonnes scrub per hectare

5 t/ha  Light to moderate understorey of scrub and grass tress. Leaf litter represents an additional 8.3 t/ha of fuel.
5.5 t/ha  Moderate understorey of introduced grasses with a sparse regrowth overstorey.
5.9 t/ha  Light understorey of native sedges and grass trees. Leaf litter represents an additional 4.9 t/ha of fuel.
6.9 t/ha  Light understorey of native grasses and grass trees. Leaf litter represents an additional 19.2 t/ha of fuel.
7.5 t/ha  Light understorey of grass trees. Leaf litter represents an additional 11 t/ha of fuel.

February 2012
7.8 t/ha  Light to moderate understorey of shrubs and grass trees. Leaf litter represents an additional 17.6 t/ha of fuel.

November 2011
8 t/ha  Understorey of native sedges and shrubs.
8.1 t/ha  Understorey of clumped native sedges with an open overstorey.
9.2 t/ha  Mixture of scrub fuels and grasses. Leaf litter represents an additional 6 t/ha of fuel.
10–15 tonnes scrub per hectare

10.5 t/ha  Light to moderate understorey of native shrubs with some sedges.
10.7 t/ha  Light to moderate understorey of shrub, scrub and grasses. Leaf litter represents an additional 10.2 t/ha of fuel.
11 t/ha  Moderate understorey of native scrub and grasses.

July 2013
11.1 t/ha  Scrub fuel load associated with the open Jarrah forest.
11.2 t/ha  Bracken fern with introduced grasses and blackberry bushes from 90–120 mm high.

January 2007
11.9 t/ha  Moderate understorey of grass trees. Leaf litter represents an additional 11.9 t/ha of fuel.
12.5 t/ha  Moderate understorey of native scrub.

November 2011
12.7 t/ha  Dense understorey of native grasses and sedges. Leaf litter represents an additional 10 t/ha of fuel.
12.8 t/ha  Dense understorey of introduced grasses and sedges.

January 2007
12.9 t/ha  Moderate understorey of introduced weeds and grasses to 900 mm in height.
13.1 t/ha  Moderate understorey of introduced grasses and a Zamia Palm. Leaf litter represents an additional 11.1 t/ha of fuel.
13.8 t/ha  Sparse coastal shrub vegetation with no overstorey.
14.1 t/ha  Dense understorey of native grasses and grass trees. Leaf litter represents an additional 6.7 t/ha of fuel.

December 2012
14.9 t/ha  Moderate understorey of native sedges with open overstorey.

January 2007
15–20 tonnes scrub per hectare

15 t/ha  Dense wetland sedges.

June 2013
15.6 t/ha  Heavy understorey of introduced grasses. Note the multiple years of grass fuels in the area.

June 2013
16.3 t/ha  Moderate to dense understory of scrub vegetation. Leaf litter represents an additional 6.8 t/ha of fuel.
17.4 t/ha  Very dense fuel load of native scrub.
19.1 t/ha  Very dense coastal shrubs and grasses with no overstorey.
20–25 tonnes scrub per hectare

20 t/ha  Very dense coastal shrub vegetation with no overstorey.
25–30 tonnes scrub per hectare

25 t/ha  Very dense vegetation of native sedges and shrubs to 900 mm in height.

January 2007
25.3 t/ha  Native scrub and grass trees with no overstorey.
**Glossary**

**Available fuel load**  
The amount of fuel in the area that will burn under the current or prescribed conditions.

**Fuel load**  
The oven dry weight of fine fuel (<6 mm in diameter dead material, <3 mm live) per unit area—commonly expressed as tonnes per hectare.

**Introduced species**  
Non-native species (not occurring naturally in the area).

**Leaf litter**  
The accumulated layer of leaves on the ground from vegetation, generally considered as a component of the surface fuels.

**Near surface**  
Live and dead fuel, including suspended leaves, bark or twigs, effectively in touch with the ground but not lying on it, with a mixture of vertical and horizontal orientation.

**Overstorey**  
The topmost layer of a forest community, generally the tree crown (or canopy) layer.

**Surface fuels**  
Litter fuels made up of leaves, twigs, bark and other fine fuel lying on the ground, predominately horizontal in orientation.

**Total fuel load**  
The total amount of fine fuel in the area.

**Understorey**  
The vegetation layer between the overstorey or canopy and the ground layer of a forest or woodland community formed by shade tolerant trees or shrubs.
Appendix 1: Litter depth and weight

Table 1. Relationship between Litter Depth and Total Litter Weight in Forest Areas.\textsuperscript{2}

Table includes twigs up to 10 mm diameter.

<table>
<thead>
<tr>
<th>Litter depth (mm)</th>
<th>Karri dominant</th>
<th>Mixed M., J., K.</th>
<th>Jarrah dominant</th>
<th>P. pinaster needle</th>
<th>P. radiata needle</th>
<th>Wandoo</th>
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<td>Litter weight (tonnes/ha)</td>
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</table>

Enter table with litter depth and forest type and read off the total litter weight.

Leaf litter depth varies depending on the type and age of overstorey vegetation including the period between burning times. Older fuel will generally have a greater amount of leaf litter available.

Table 2. Relationship between Litter Depth and Total Litter Weight in Banksia Woodlands.3

<table>
<thead>
<tr>
<th>Litter depth (mm)</th>
<th>Litter weight (tonnes/ha)</th>
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</thead>
<tbody>
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<td>40</td>
<td>21</td>
</tr>
</tbody>
</table>

Table includes dead material (leaves and twigs) less than 6 mm in diameter and all live vegetation that is less than 3 mm in diameter. To calculate the litter weight using Table 2, choose the closest measured litter depth and read off the total litter weight.

**Methodology to measure leaf litter**

Leaf litter depth of Banksia litter can be determined using the following steps:

1. Using your finger or probe, carefully clear away the leaf litter down to the mineral earth to create a hole of around 4 cm in length.

2. Ensure the litter on one side remains completely undisturbed.

3. Remove any large obstructions such as twigs, rocks or nuts greater than 6 mm diameter from where the litter depth gauge will rest.

4. Push the base of the gauge downwards onto the litter, with as much force as it would take to hold a tennis ball under water.

5. Press the slide of the litter depth gauge firmly against the soil without pushing into the soil surface. Firmly hold the slide against the case and take note of the measurement revealed on the ruler.

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3 Environmental Protection Branch. 2015. *Fuel Loads in Banksia Woodlands*. Department of Fire and Emergency Services, Perth, WA.