EFFECTS OF THINNING ON FOREST STRUCTURE AND COMPOSITION IN THE WUNGONG CATCHMENT, WESTERN AUSTRALIA

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Declaration

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary educational institution.

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Sita Ram Panta

Abstract

The focus of jarrah (*Eucalyptus marginata* Donn ex. Smith) forest management in past decades has been changing in response to forest management practices of the day, interests and needs of the forest users and more recently a changing climate. Following uncontrolled logging including clear-felling and wild-fires after European settlement (1830s onwards) and rotational logging and burning under the state forest management plan, much of the old-growth forest of south-west Western Australia has been converted into a dense re-growth forest. Substantial reduction in the rainfall in the south-west of Western Australia in the past three decades has resulted in a significant decrease in water available to the Integrated Water Supply Scheme at a time of increasing water demand of the region. A forest thinning trial to increase both water yield and environmental benefits from the catchment has been implemented since 2006 in the Wungong Catchment within state forest. Wungong forest is now managed by the Water Corporation as a drinking water catchment in association with the Department of Environment and Conservation (DEC) and Forest Product Commission (FPC); and is under the scrutiny of Environmental Protection Authority (EPA) of Western Australia. Although the effects of forest thinning on catchment hydrology are well understood, short-term effects of thinning on forest ecosystems especially on forest structure and composition are less well understood. The research reported in this thesis contributes to understanding the short-term effects of thinning on stand structure and on the composition of overstorey and understorey components of the forest, including the dead woody debris (DWD).

Two thinning strategies, i.e., commercial logging followed by glyphosate herbicide treatment of selected non-commercial trees (log+notch) or killing of selected trees by applying glyphosate herbicide to notches in the trunk (notch-only), were compared as treatments to the adjacent unthinned stands (control) in the Wungong Catchment within jarrah forest of south-

west Western Australia. All three treatments were replicated three times using plots of 90 x 70 m size. Thinning, which was carried out in September, 2009, reduced tree basal area from 50.2 to 17.9 $m^2 ha^{-1}$ for log+notch and 43.8 to 22.2 $m^2 ha^{-1}$ for notch-only treatment.

Forest structure variables were investigated in relation to thinning *viz*: stand density and basal area for three dominant tree species and their composition in the overstorey; understorey species richness and ground cover; and quantity, structure and composition of DWD.

This study revealed that both log+notch and notch-only thinning treatments significantly reduced the overall stand density and basal area and changed the composition of the treated tree stands compared to the unthinned stands. Frequency distributions of the tree stands in different size classes were altered with highly significant decreases in 20-30 and 30-40 cm diameter at breast height (DBH) classes. By contrast, no significant effect was observed in the understorey species richness and ground cover within 1 year after thinning, partly due to the absence of direct physical disturbance in the sampled quadrats. However, there was a slight reduction in thinned as well as control forest in the species richness recorded during the hot and dry season compared to the winter sampling. Results suggest that selection of sampling units representing different micro-site conditions within the study area are important and the sampling area needs to be increased to 64 m^2 (16 lots of 2x2 m quadrats) to adequately represent species richness present in the study area.

Thinning increased the quantity of DWD by 100 % in log+notch and 142 % in notch-only treatments. Thinning also changed the structure and composition of DWD components (i.e. log, snag and stump) by altering the percentage contribution of each component to the total DWD pool. Thinning altered the percentage contribution of log, snag and stump components to the total DWD volume from 80, 17 and 3 % before thinning to 48, 50 and 2 %, respectively, for log+notch treatment after 1 year, and from 86, 11 and 2 % to 36, 63 and 1 %,

respectively, for notch-only treatments. Changes in the structure of the dead woody resources after thinning revealed that the amount, structure and composition of DWD in the forested catchment was directly related to stand age and structure of the living trees and more specifically to the method and intensity of forest thinning.

In summary, this study suggests that thinning as a management intervention is an important driver of the structure and composition dynamics of jarrah forest ecosystems. The level of reduction in the stand density and basal area of the tree stand and increase in the amount of DWD as compared to the adjacent control stands were dependent on the methods and intensity of thinning. Although the effects of thinning on overstorey components such as species composition, stand density and diameter size-class distribution of tree stands, and on DWD components were significant, effects on understorey species richness and ground cover were not discernable in the short-term. Hence, longer term study of post-thinning vegetation structure and composition are needed to adequately describe thinning impacts on post-thinning vegetation dynamics and successional processes.

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Abbreviations and Symbols

DEC	Department of Environment and Conservation
DWD	Dead Woody Debris
CWD	Coarse Woody Debris
FPC	Forest Products Commission
CALM	Conservation and Land Management
CC	Conservation Commission
EPA	Environmental Protection Authority
FDWA	Forest Department of Western Australia
WA	Western Australia
USA	United States of America
USDA	United States Department of Agriculture
DBH	diameter at breast height (1.37 m)
TDM	total dry mass
BA	basal area
LAI	leaf area index
NA	not applicable
ha	hectare

mm	millimetre
cm	centimetre
m	metre
m^2	square metre
ha^{-1}	per hectare
$year^{-1}$	per year
˚C	degree centigrade
g	gram
l	litre
t	tonne
kg	Kilogram
ln	natural log
>	more than
<	less than
≥	more and or equal to
≤	less and or equal to
L	Log+notch treatment
C	Control treatment
N	Notch-only treatment

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Dedication

Dedicated to my late father

Chhabi Lal Panta