1. INTRODUCTION

1.1 BACKGROUND

The region referred to as the ‘Great Western Woodlands’ (hereafter, GWW) includes most of the contiguous residual natural woody vegetation to the east of the wheatbelt in south-western Western Australia. Before European settlement, south-western Western Australia supported a natural woody vegetation cover of woodland and shrubland (Figure 1.1a). In the past two centuries, about half of this woody vegetation has been cleared and replaced with agricultural production—mostly wheat (Figure 1.1b)—and is commonly referred to as the ‘wheatbelt’. The GWW region to the east of the wheatbelt was found to be less suitable for agricultural crops or livestock grazing. Nonetheless, development of the GWW continues to be proposed. In 1979, the WA Government proposed an extension of farming across the southern half of the GWW (Bradby 2008). In 1992, the WA Department of Conservation and Land Management and Goldfields residents established the Goldfields Specialty Timber Industry Group Incorporated with the aim of exploiting the timber resources of the GWW (Siemon and Kealley 1999). Despite early attempts at development, the vegetation remains largely in a natural state in that it has not been subject to broad-scale land clearing and intensive agricultural development. The region, however, overlies the Late Archaean granite-greenstone terranes of the Eastern Yilgarn Craton—geological formations containing high-quality gold and nickel deposits. Consequently, much of the region has been impacted on by mineral exploration and mining. Major impacts on the natural vegetation include: 1) timber cutting before 1975 to provide mining timber and firewood for the goldfields and water-pumping stations; 2) the creation of numerous access tracks and seismic lines; and 3) changes to the fire regime. The impact of changed fire regimes demands special attention as previous studies show that this can lead to the conversion of woodland to a mallee–shrubland vegetation type (Hopkins and Robinson 1981).

The current and future conservation status of the GWW is of increasing concern and there is a need to gain a more quantitative understanding of the environmental services the region provides. The biodiversity significance of the GWW, including its high levels of endemic plant species and the importance of large areas as bird habitat, is known (Duncan et al. 2006; Newby et al. 1984; Recher et al. 2007). Particularly important, however, in the context of the climate change problem, is the role of the GWW’s vegetation ecosystems in carbon storage. Carbon storage in natural ecosystems of the biosphere is referred to as ‘green carbon’ (Mackey et al. 2008). Green carbon is stored in woody plant tissues of living trees and shrubs, dead stems, coarse woody debris on the ground and organic matter (derived from decomposition of plant tissues) in the upper soil layers. The GWW is a large area of natural woodland that potentially includes a significant component of the green carbon stock within Western Australia.

As the world’s nations seek solutions to the global problem of climate change, increasing importance is being given to reducing emissions from deforestation and degradation in developing countries—the so-called REDD agenda (UNFCCC 2007). The REDD agenda is, however, not focused on forests in developed countries. From a scientific perspective, as the atmospheric warming caused by a pulse of
carbon dioxide is the same regardless of the source, it is necessary to consider emissions from natural ecosystems in all countries, including Australia. Emissions from land-use activities in developed countries such as Australia are covered under the so-called ‘Land Use, Land Use Change and Forestry’ (LULUCF) rules in the Kyoto Protocol. The role of forests and other natural ecosystems in carbon storage is, however, presently unaccounted for by Australia unless deforestation has occurred. Therefore, new policies and measures are needed that reward land stewards for avoiding emissions from, and restoring carbon stocks in, natural forest and woodland ecosystems.

A prerequisite to good climate change mitigation policy is a reliable assessment of an ecosystem’s green carbon stocks. Carbon storage in ecosystems can be assessed in terms of their current carbon stock relative to their natural carbon carrying capacity (Keith et al. 2010). Current carbon stock represents the actual carbon stock at a given time and includes the effects of the direct impacts of past disturbances due to human activities such as logging and clearing for pastoralism. Carbon carrying capacity is the amount of carbon terrestrial ecosystems can store when averaged over an appropriate time scale and area, inclusive of the landscape-level impacts of natural disturbance regimes such as fire.

The current carbon stock of terrestrial ecosystems (plants and soil) globally is at least 2000 Gt C, with about 75 per cent in forest ecosystems and 25 per cent in other ecosystem types (Houghton 2007). The international definition of forests, however, includes structural formations that in Australia are defined as woodlands and shrublands (AUSLIG 1990), such as those that characterise the GWW. We need to avoid emissions from all sources if we are to succeed in stabilising atmospheric levels of carbon dioxide at a level that prevents dangerous climate change (IPCC 2007). Protecting and restoring the green carbon stocks in ecosystems such as the GWW can contribute to solving the global climate change problem.

Human activity can lead to either an increase or a decrease in the frequency of fires and a change in fire regimes (that is, the pattern of fire events) (Gill 1975). This change in fire regimes can be considered an indirect effect of humans on an ecosystem’s carbon carrying capacity. On a landscape-wide basis, forest ecosystems have been shown to be relatively resilient to fire due to a combination of factors, including: i) the existence of very large old trees that are fire resistant; ii) the presence of tree species with fire-adapted plant life history traits; iii) the occurrence of fire refugia due to landform complexity; and iv) negative feedbacks on flammability (Mackey et al. 2002). The impact of fire regimes on the carbon carrying capacity of woodland ecosystems is, however, poorly studied. As noted above, the available evidence suggests that the woodlands of the GWW could be less resilient to changes in the fire regime than are the wetter eucalypt forests of south-western and south-eastern Australia (Hopkins and Robinson 1981).

In summary, the current carbon stocks of woodland ecosystems can increase or decrease due to: 1) variation in the natural conditions that control plant growth and decay; 2) direct human impacts such as timber cutting and land clearing; and 3) indirect impacts of humans on fire regimes. By definition, carbon carrying capacity represents the carbon stock of an ecosystem inclusive of natural but not anthropogenic disturbance. Therefore, the carbon carrying capacity provides a baseline with which to compare the current carbon stock in order to assess the impacts of human activities. Such analyses make it possible to identify management options for protecting and restoring ecosystem carbon stocks at the landscape scale.
1.2 AIMS

The aims of this report are to

• quantify the current carbon stock of the GWW
• assess how this differs from the carbon carrying capacity
• identify the impacts that have reduced the carbon carrying capacity due to the direct and indirect impacts of human activities
• recommend possible management options for protecting and restoring the carbon carrying capacity of the GWW.
Figure 1.1a

Figure 1.1b

Figure 1.1 Natural vegetation (a) and present vegetation (b) as mapped by Carnahan (AUSLIG 1990). The GWW study area is outlined in red. Vegetation coding: growth form of the tallest stratum is indicated by letters. T = tall trees (>30 m); M = medium trees (10–30 m); L = low trees (<10 m); S = tall shrubs (>2 m); Z = low shrubs (<2 m); H = hummock grasses; G = tussocky or tufted grasses and graminoids; F = other herbaceous plants. Foliage cover of the tallest stratum is classified into numeric classes: 1 = <10%; 2 = 10–30%; 3 = 30–70%; 4 = >70%.

These figures incorporate natural vegetation and present vegetation data that are Copyright Commonwealth of Australia 2003.