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Toward sustainable management: Southern Africa's Afromontane, and Western Australia's jarrah forests

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ABSTRACT: We review the history of forest management in two southern hemisphere forest types: Western Australia's jarrah Eucalyptus marginata forests and the Afromontane forests of southern Africa to determine approaches for achieving sustainable forest management. We argue that despite major differences in the ecology and biogeography of these two forest types, a shared pattern in the history of exploitation may provide lessons for achieving sustainable management across forest types. While advanced silvicultural understanding has long been achieved in both forest types, this in itself has not led to either sustainable management or to public acceptance of forest management regimes. In both areas an early, rapid expansion of uncontrolled timber removal and in the number of operating timber mills was followed by controlled exploitation, a rapid decline in the numbers of mills and, more recently, a general decline in yield. In neither case was increased concern about conservation responsible for the reduction in either yield or in employment in the industry. Rather, in WA jarrah forests, amendments in purpose and tenure were subsequent to the loss of most mills and towns, while in southern Africa's Afromontane forests, timber workers were pensioned by 1939 because of scanty remaining merchantable timber. In the jarrah forests, we believe that the conflict generated by conservation concerns, reduced timber industry employment, and reduced benefits flowing to the communities adjacent to the logged forests, has fueled dissatisfaction with forest management outcomes. This has led to a new process in the preparation of forest management plans. Increased accountability and more realistic expectations of timber yield following productivity declines may mean the current plan for the forests of Western Australia can be used as an example to achieve sustainability in Mediterranean forest ecosystems. However, general acceptance of management regimes may not be achieved until the scale of logging operations is matched with local sustainability criteria. Increasing the area of reserves will not accelerate this process, but rather may impede it. Setting conservative overall yield estimates, and achieving local sustainability seem both to be necessary to achieve general acceptance of management regimes. A sustainable management system appears to have been achieved in the Afromontane forests and has led to the development and maintenance of support for small-scale operations to supply local timber needs from State managed forests. In both environments such a process is achievable because of the high value and specialized nature of the native forest timber resource, and because of the increasing availability of general purpose timber from plantations.

1 INTRODUCTION

Reviews of the history of resource exploitation present a dismal picture (e. g. Ponting 1991, Hillborn et al. 1995) and it is unlikely that we shall ever attain scientific consensus concerning the systems that are being exploited (Ludwig et al. 1993). Therefore social acceptability of favoured management options is crucial, and historical case studies are instructive because they show social, political, economic and scientific responses to earlier measures.

In this paper, we review the history of exploitation in two southern hemisphere case studies: the Afromontane forests of the Southern Cape, South Africa and the jarrah forests of south-western Australia. These forests differ in ecology and biogeography. However, they do provide similarities with respect to their patterns of exploitation, and provide insight into the ability and commitment to achieving sustainability in each case across centuries. We begin by briefly overviewing the ecology and biogeography of these forests and their history of exploitation and silviculture. We then assess efforts to achieve sustainable forest use in each case, with particular emphasis on the use of small-scale local operations in the Afromontane compared to a broader approach in the jarrah forest. In the light of historical experience and, in particular the scale of logging operations, we consider whether ecologically sustainable forest management can be achieved in the current management plan (Conservation Commission of Western Australia - WA 2004) for the south-western Australian forests.

2 DISTRIBUTION AND ECOLOGY OF THE FORESTS

2.1 *The Afromontane forests of the Southern Cape*

Southern Africa, like much of Australia is largely semi-arid or arid, with indigenous forests, occupying less than 0.5 % of the total land area (Midgeley et al. 1997). However, even in the relatively moist fertile regions adjacent the south and east coasts, areas that have a capacity to support forests tend to be grasslands due to the naturally high frequency of fire occurrence (Bond 1997). The indigenous forests of the region are thus confined to the most sheltered and protected areas. The Southern Cape indigenous forests occur in a narrow coastal strip extending over 250 km on the south-east coast of southern Africa (Midgeley et al. 1997 and included references). These multi-species (at least 86 species are classed as trees in the area) multi-aged Afromontane forests extend over 65 000 ha. They represent the remnants of the largest natural forest complex in South Africa in an area of moderately high (550 to 1200 mm rainfall annually) and evenly distributed rainfall, and mild temperatures. The forests are dominated by several species valued for their timber including Ocotea bullata (stinkwood), Apodytes dimidiate (white pear), Curtisia dentata (assegai) and Olea capensis spp macrocarpa (black ironwood), with emergent species including Podocarpus falcatus (yellow wood), a species much sought after for fine woodcraft. These forests are noted for their heterogeneity with up to 24 species of trees occurring in a hectare - including isolates of rare tree species such as Strychnos decussata, Hippobromus pauciflorus, Prunus africana and Strelitzia alba. This area includes high altitude forest as well as forest along watercourses, and is part of a mosaic of vegetation types (biomes) that includes fynbos (Midgeley et al. 1997 and included references).

2.2 *The jarrah forests of south-western Australia*

The forests of south-western Australia occur principally in three biogeographic regions: Swan Coastal Plain, Jarrah Forest and Warren (Wardell-Johnson et al. 1997). These regions encompass that part of the south-west receiving more than 600 mm mean annual rainfall - an area of about 4.25 million hectares. Approximately 2.5 million hectares of publicly managed land occurs within

this region (Conservation Commission, WA 2004). The Mediterranean-type climate is characterized by mild winters, a pronounced winter rainfall maximum, and the regular occurrence of summer/autumn drought (McCaw and Hanstrum 2003). Jarrah (*Eucalyptus marginata*) occurs throughout the region where it displays a range of growth forms from shrub to tall forest tree (Wardell-Johnson et al. 1997). It is the most important of Western Australia's commercially important hardwood trees and is most dominant in the Jarrah Forest Bioregion, a heavily lateritized landscape, where it can occur as the dominant overstorey tree over large areas. Karri *E. diversicolor* is also a commercially important species, occurring mainly in the Warren Bioregion, while other species such as marri *Corymbia calophylla*, and blackbut *E. patens* often co-occur with jarrah or karri, while wandoo *E. wandoo*, occurs inland to the east of the distribution of jarrah. Inland, these forests grade into woodland and mallee dominated bioregions which are now extensively cleared for agriculture. In each of these bioregions, forests occur in a matrix of vegetation types reflecting an extraordinarily long and complex geological and climatic history (Wardell-Johnson and Horwitz 1996). Detailed accounts of the distribution, history, silviculture and ecology of the jarrah forests have been presented (Dell et al. 1989, Bradshaw et al. 1991, Wardell-Johnson et al. 1997 and included references, Stoneman et al. 2005).

3 FOREST MANAGEMENT IN THE AFROMONTANE FORESTS

3.1 *The Afromontane forests of the Southern Cape prior to the Forests Act (1913)*

Prior to European settlement of the Cape in 1652, local people used the Afromontane forests both for slash and burn agriculture and the selective use of small to medium-sized poles and saplings for a range of forest products for domestic and agricultural use (Hoffman 1997). European colonists had different tools and different needs from the forests, and as a result, the small area of forest in the Western Cape disappeared soon after settlement (Grut 1965). The search for timber led to the location of the Afromontane forests of the Southern Cape by 1711 (von Breitenbach 1974). Early exploitation was wasteful and without regard to regeneration. After the Cape colony passed from Dutch to British control in 1806, some interest was shown in the forests, although when expectations proved optimistic, they were again abandoned. In 1847, the forests were closed from exploitation and a conservator of Forests appointed, but it was not possible to prevent illegal felling (Grut 1965). At this time the government sold much of the worked out portions of the forests for agriculture (von Breitenbach 1974). In 1856 the forests were again opened for controlled exploitation and additional conservators were appointed. Nevertheless, uncontrolled felling continued. In 1880, the post of Superintendent of Woods and Forests was created, but was not filled following the retirement of the first Superintendent (Count de Vasselot de Regne) in 1891. Thereafter the conservators were directly responsible to the Commissioner of Crown Lands and Public Works. Nevertheless, the introduction of systematic forest management in 1880 also saw the initiation of a program of plantation development, which had major subsequent implications for conservation.

3.2 *The Afromontane forests following the Forest Act (1913)*

By the time a joint South African forest service was created in 1910, many licensed woodcutters depended on the Afromontane forests but there was general recognition that they could not be maintained (Grut 1965). The Department of Forestry obtained powers under the *Forests Act* (1913) to limit the number of licensed cutters to those already established in the area at that time. Thus the number of registered woodcutters declined from 1267 in 1911 to 628 by 1923-24 (Grut 1965). However, volumes of timber removed, which were already considered to be above replacement yield, did not immediately decline and timber output was rapidly exhausted. By 1939, the Afromontane forests contained little merchantable timber, and timber cutting was suspended for the next 27 years. The remaining woodcutters were provided with an annual pension through the *Woodcutters Annuities Act* (1937). Nevertheless, the rapidly expanding plantation program allowed them to be employed in other activities of the Department of Forestry.

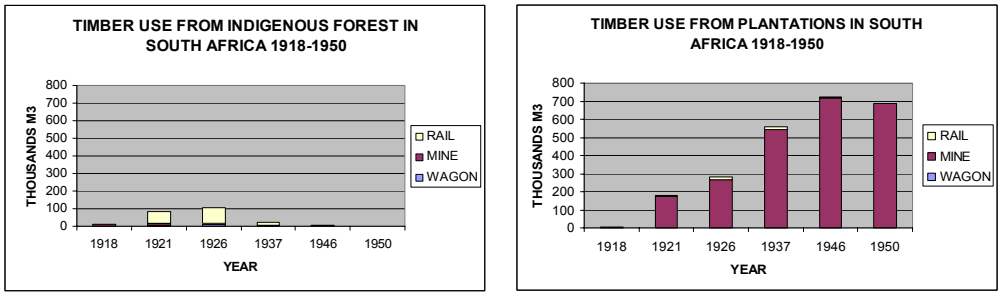

Figure 1. Tree products extracted from indigenous forests and alien plantations (chiefly *Pinus* sp and *Eucalyptus* sp. in South Africa between 1918 and 1950 and used for wagon wood, mine props and railway sleepers (Data from Anon 1961, Hoffman 1997).

3.3 *Afforestation in South Africa*

The Department of Forestry established its first plantation (about 30 ha of eucalypts near Worcestor) in 1876 to supply firewood for the railways. Plantations of introduced *Pinus radiata* were established near Knysna in 1883/4 (Grut 1965). Subsequently other species of *Pinus* such as *P. patula* became more significant. The isolation of South Africa during World War 1 and high prices for the small area of existing harvestable plantation led to an energetic policy of afforestation aiming at 10-15 000 ha per year (Grut 1965). From the beginning the Department of Forestry concentrated on the production of coniferous sawn timber, while the production of mine props (mostly eucalypts) and wattle bark which require a rotation of less than 10 years was left to private enterprise. Social motives also lay behind government interest in afforestation, for thereby work could be provided for the woodcutters unemployed following closure of the indigenous forests.

Grut (1965) concluded that the greatest impact of humans on the Afromontane forests in the 100 years before his review was between 1890 and 1940 (see also data of Anon 1961 - used to derive Figure 1). Despite decreasing numbers of woodcutters, timber removals increased until immediately before recognition of the depletion of the forests. However, the considerable areas of highly productive pine plantation allowed a transition and a respite for the Afromontane forests. Grut (1965) also argues that the rise of motorized transport, and the increasing dependence on introduced plantation species for construction timber led to a dramatic decline in the demand for indigenous forest products (Fig. 1).

3.4 *The development of silviculture and yield regulation*

Various management systems were applied prior to 1939 but with little success (Von Breitenbach 1968, Von Dem Bussche 1975, Donald and Theron 1983). In 1880 a formal system of forest management came into effect whereby sections of forest were demarcated for working, then left to recover for 40 years. In these sections the prime timber species were marked, and felling controlled. Regardless, fellings continued beyond the capacity of the forests. Following the closing of the Afromontane forests to exploitation in 1939, timber extraction was restricted to windthrow and dying trees. Research was conducted to determine the sustained yield of the timber from these forests and by 1960, the forests were considered capable of yielding timber (Seydack et al. 1995, Seydack 2000). In 1966 a new system of forest management was developed which allowed for selective tree removal.

Since 1966 logging followed the Senility Criteria Yield Regulation System (SCYRS) developed by Seydack (Seydack 1995, 2000, Seydack et al. 1995). This explicit yield-regulation system stipulates the number of trees (or volume) to be harvested per hectare and the spatio-temporal layout of those trees (spatial grain of harvesting operations, felling cycle), and it also defines which trees are

harvestable (selection criteria). A ten-year felling cycle applies representing a compromise between the cost-effectiveness of management, which favours long felling cycles (Seydack 2000), and the prevailing disturbance regime, which favours short felling cycles (Midgeley et al. 1997). Most trees in this forest die standing, implying a protracted period of decline and/or stagnation. Selection criteria have been established for each tree species so that the most senile trees (equivalent in number to the associated ten-year mortality rates) can be identified (Seydack et al. 1995). Between eight and ten canopy trees ha-1 are potentially harvestable every ten years with *Ocotea bullata*, *Podocarpus latifolius* and *Olinia ventosa* being the most sought after species. This yield regulation system accounts for differences in forest dynamics or tree life-histories. Continual monitoring of ingrowth and mortality patterns for individual canopy species is conducted in individual production compartments. The monitoring of forest dynamics in both harvested and non-harvested stands is an important part of this yield regulation system, and is particularly important for safeguarding sustainability should harvesting deviate from the natural disturbance regime.

Logs are removed from the forest with minimum disturbance to the understorey and the biota, either by helicopter, horses or specially designed soft-tyred vehicles. Large utilizable trees marked for removal are topped before felling to minimize damage to surrounding forest and to maintain canopy closure. Timber extraction is limited to dry periods to minimize soil compaction (Seydack et al. 1995).

4 FOREST MANAGEMENT IN THE JARRAH FORESTS

4.1 *The history of forest management in the jarrah forests*

Logging of jarrah forest commenced soon after European settlement in Perth (1829), with the first sawmill operating by 1833. Most areas of the northern jarrah forest were logged over the 175 years of European forest management (Heberle 1997). Forest management was often contentious, and several Royal Commissions were established (Calver and Wardell-Johnson 2004). Initially, there was almost unimpeded exploitation, intensifying between 1880 and the promulgation of the *Forests Act* in 1918 (Calver and Wardell-Johnson 2004 and included references). This was followed by expansion of State forest, silvicultural reconstruction, fire exclusion and emphasis on timber production and water catchment protection until the mid 1960s. The area of State Forests rapidly expanded after 1918, such that by 1929, it approximated 60 % of its extent in the year 2000. After 1929, expansion of State forest reservation tailed off in the jarrah forest regions. Up until 1954 only about 100 000 ha more were added, with most in 1938 (Rundle 1996). After World War 11 (as after the Great War) a conflict of interest arose between demands for unallocated forest land to be released for post-war agricultural development. Nevertheless a further 200 000 ha were added to State Forest in the south-west up to 1958, with about 100 000 ha more on the Swan Coastal Plain earmarked for conversion to pine plantation shortly thereafter (Rundle 1996). Thus by 1969, State forests and timber reserves in the south-west totaled some 1.8 million hectares. While the area of State forest stabilized from 1929 to 1952, the volume of jarrah sawlogs (and hewed sleepers) removed fluctuated markedly, largely as a result of international events. Thus, there were major declines during the Great Depression and the 2nd World War but with substantial increases shortly thereafter (Calver and Wardell-Johnson 2004).

The post 1960s was characterized by recognition of multiple-use values in management plans, replacement of fire exclusion with prescribed burning, intensive utilization of forest products and the introduction of large-scale extractive industries such as bauxite mining within the jarrah forests (Calver and Wardell-Johnson 2004 and included references). Following a joint Commonwealth and State Government attempt to provide security for both forest reserves and resource availability in the late 1990s (Regional Forest Agreement), the Australian Labour Party (ALP) secured State Government with a policy of ending logging in old-growth forest in Western Australia (2001). While there was a general decline in jarrah timber yield throughout this period (Calver and Wardell-Johnson 2004), the new management planning approach adopted by the incoming government

(Conservation Commission, WA 2004) led to an unprecedented reduction, thus heralding a new era in forest management for Western Australia.

4.2 *A new forest management plan for Western Australia*

The new Western Australian Forest Management Plan (Conservation Commission, WA 2004) adopted Montreal Criteria of sustainability as the framework within which to identify management actions. For each of these criteria the management plan provided objectives and actions enabling compliance. Key performance indicators were provided for each of these criteria (except carbon cycles) such that performance measures, targets, reporting and responses to shortfalls in targets were identified. The linking of criteria, objectives, actions and performance indicators allowed transparency in assessment. Furthermore, sections associated with biodiversity were seriously considered despite the lack of a sound basis for presenting biodiversity gradients across the forest regions (see McKenzie et al. 1996, Wardell-Johnson and Horwitz 2000). The plan has adopted three scales of management; whole of forest, landscape and operational. Protection of fauna habitat (and 'habitat trees') relies on surrogates until knowledge of factors affecting distribution patterns accumulates (Wardell-Johnson et al. 2004). Nevertheless, the new management plan links biodiversity and logging within the constraints of available data.

The considerable reduction in jarrah yield from the 1994 plan (CALM 1994 - 394 000 to 131 000 m^3 per annum – first and second grade logs) was recognition of the need for change from previous visions of the variety of products that forests provide. There was recognition in the plan of a reduced area available for timber harvesting as a result of an expansion of the formal and informal reserve system, the creation of fauna habitat zones, changes to silviculture and provision of risk factors such as the impact on timber yields resulting from the forecast spread of *Phytophthora* (Conservation Commission, WA 2004). The plan recognized the threat to ecosystem health from the plant pathogen *Phytophthora cinnamomi* and provided greater commitment to identifying protectable areas, and instituting measures to minimize the risk of infecting them during forest operations. Furthermore, considerable emphasis on monitoring the implementation of the policy and reviewing its adequacy was provided in this plan.

The plan placed considerable emphasis on mechanisms for checking implementation and improving performance. Systematic and informal monitoring were expanded, performance indicators for assessing the effectiveness of the plans implementation were introduced, formal adaptive management through experiment was prescribed and compliance auditing with public reporting was expanded. The plan also recognized the existence of mineral and petroleum operations on land to which the plan applies, but which are approved and conducted through government processes outside the control of the plan.

4.3 *A recent history of conservation reserves in State forest*

While the area of State forest has been relatively constant since the 1960s, controversy generated by several broadscale industrial ventures within State forest (bauxite mining, woodchipping; and replacement of jarrah forest by pine plantation in the Blackwood Plateau) led to early consideration of extensive areas of State forest to be set aside from timber production. The concept of Management Priority Areas (MPAs) first appeared in General Working Plan 86 in 1977 (Forests Department 1977) but had been considered from the early 1970s with the Perup Fauna Priority Area being promoted in the Forests Departments publicity journal in 1973 (Christensen 1973). The key MPAs in a conservation sense were those identified as having wildlife or recreation priorities (White 1977, Heddle et al. 1980). However, conservation groups argued that security of purpose should not to be equated with security of tenure and urged that the vesting of these areas be altered to reflect their purpose. Such changes were foreshadowed in General Working Plan 87 of 1982 (Beggs 1982). While this plan set in train the transfer of over 500 000 ha from forest reserves to conservation reserves, these areas had effectively not been available for timber production since the early 1970s. In 1994, the State Government adopted Ecologically Sustainable Forest Management from native State forest as policy (CALM 1994), and proposals to transfer forest reserves to conservation

reserves continued despite administrative complexity. The 2004 forest management plan (Conservation Commission, WA 2004) formally recognized their lack of availability for timber production. However, this plan also increased substantially other areas to be allocated as conservation reserves, particularly a large area in the Warren and southern part of the Jarrah Forest Bioregions to be formally named the Walpole Wilderness Area, an expansion of the previously gazetted Lane Poole National Park, and several areas of the Blackwood Plateau (Conservation Commission, WA 2004).

4.4 *Timber harvest and technological innovation*

The rapid early expansion of the number of mills and towns preceded the formation of the Forests Department and the rapid increase in the area of jarrah forests dedicated as State Forest following promulgation of the *Forests Act* (Wardell-Johnson and Calver 2004). Similarly, the reduction in mills and towns preceded the changes in purpose and tenure of some State forests to conservation and recreation management priority areas (MPAs and subsequently to national park and nature reserve) commencing in the 1970s (Wardell-Johnson and Calver 2004). The pattern was also not associated with the volume of jarrah logged. This fluctuated markedly during the 20th century despite a relatively consistent area of available State forest after 1930. The prolonged downward trend in jarrah yield commencing in the late 1960s (Calver and Wardell-Johnson 2004) preceded changes in purpose. However, the considerable reduction following the 2004 plan accompanied a major reduction in area of State forest available for timber production.

Timber harvest from jarrah forests was closely associated with technological change in felling, snigging, hauling and sawing methods (Heberle 1997, Stoneman et al. 2005). An early rapid expansion in operating timber mills prior to the formation of the Forests Department in 1919 was followed by a similarly rapid collapse, particularly for small mills which also had the lowest life expectancy (Wardell-Johnson and Calver 2004). There has thus been increasing emphasis towards mechanization, allowing long-distance transport through innovations in road building and log truck design, and limited large, efficient mills with large catchment areas employing relatively few (Clark 2003, Wardell-Johnson and Calver 2004). Thus many important innovations have contributed to greatly increased production per person since logging in the jarrah forests began.

4.5 *Socio-economic benefits and conservation*

Socio-economic benefits were outside the brief of the 2004 management plan (Conservation Commission of Western Australia Personal Communication 2004) and only two performance indicators were identified for the maintenance of socio-economic benefits in the new plan (the number, range and use of recreation and tourism activities available by proposed land use category in the plan area; and basic raw material supply). However, socio-economic benefits associated with the new management planning process were considered in a supplementary social and economic impacts report (Day and Associates 2002). That report was commissioned by the Forest Policy Implementation office, the main objective being to compare the socio-economic impacts associated with two timber management scenarios (A – a timber yield of 106 000 m^3, and B – a yield of 164 000 m^3). Alternative options such as those based on smaller scale local industries were not considered. The project particularly targeted the shire of Manjimup, and considered immediate impacts of reduction to the two nominated levels on the existing jobs, while maintaining existing industry structure. Thus, there was no consideration of the continuing impacts of removing timber from forest in other shires to support the timber industry in Manjimup on continuing public support for the plan. While detailed silvicultural prescriptions were considered to reduce impacts on soils, understorey and regrowth, as well as on *Phytophthora*, no attempt was made to identify whether alternative silvicultural regimes designed for a more local production scale could be implemented within the various forest regions.

5 SUSTAINABILITY IN THE AFROMONTANE FORESTS

5.1 *Sustainability and yield regulation in the Afromontane forests*

The introduction of SCYRS recognized that sustainable timber production has several components which need to be accommodated in forest management (Goodland et al. 1990): the economic base of people in forest associated regions, extraction of non-wood products, environmental services provided by forests, and biodiversity values. Furthermore, sustainability from natural forests leads to only modest yields - rarely enough to meet local socio-economic needs. Thus reconciliation of ecological sustainability of resource use, socio-economic needs and the conservation of biodiversity has to involve sustainable societies, collaborative participatory forest management and naturalistic yield regulation systems outside protected areas (Seydack 2000). This has emphasized diverse employment opportunities in forest associated towns, such as George and Knysna, which now have national tourism as their major employment providers. Kelly (2000) has also demonstrated that diversity of industry has been a major factor in continued township survival and growth in forest areas of south-western Australia. Because the area of productive Afromontane forests was small and hence capable of supplying only a specialized local timber industry, chiefly for furniture and fine woodcraft, harvesting was designed to be compatible with the needs of people associated with the forest environment Further, the system was accompanied by accurate mapping of the entire forest area, vegetation mapping and systematic surveys of the growing stock. In addition, multiple land-use planning set aside forest areas for Timber Production, Forest Protection, Nature Reserves, Recreation and Research.

5.2 *Economics and sustainability in the Afromontane forests*

Because of the small area of available forest for timber production, high capital investments in mechanization and high quality road construction were rejected (Seydack 2000). Seydack (2000) argued that the perceived dictates of harvesting economics is one of the main causes for undesirably high harvesting intensities generally, resulting in selection of inappropriate yield regulation approaches, pressure for unsustainable harvesting levels, damage to residual vegetation, and damage to soil. Seydack (2000) in advocating new yield regulation systems for tropical forests argued that in addition to the consequences of high harvesting intensities pursued, logging damage appears to be due to inadequate compliance with rules and regulations, the use of unnecessarily powerful and heavy machinery, and insufficient supervision by responsible authorities. Highly mechanized logging with heavy machinery creates conditions not usually encountered in nature (Whitmore 1991). Particularly troublesome is soil compaction and also disruption of the soil surface, perhaps also the most serious concern in the ancient soils of the jarrah forests (see Hopper 2003). Seydack (2000) argued that because of the constraints of operational economics usually encountered in the management of tropical and subtropical forests, there is a need for carefully developed yield regulation systems which require minimal silvicultural intervention, and place the focus on innovative low impact harvesting and professional harvest tree selection. Seydack (2000) advocated the mimicking of forest dynamics and hence a further shift towards mortality preemptive approaches. Seydack (2000) argued that this would lead to forests which are structurally closer to the primary state, but suggests that at the operational level more work is required with regard to the development of maturity condition criteria and low impact exploitation approaches.

6 SUSTAINABILITY IN THE JARRAH FORESTS

South Africa is fortunate in having a large private area supporting a fast-growing timber plantation resource. South-western Australia by contrast has limited available areas for high yielding, fast-growing timber plantations, due to relatively poor soils and steep climatic gradients inland from the south-western and southern coasts. Nevertheless, realization has emerged of the imperatives of deep-rooted perennials for sustainable agricultural systems. Hence, timber plantations will play an

increasing role in the agricultural sector (Harper et al. 2001), though the appropriate species, regime and financial agreements between the Government sector and land owners remain elusive at present (Hatton and George 2001). Nevertheless, reforestation has the potential to contribute substantially to the States Timber resources, and to halt degradation in the Western Australian wheatbelt (Harper et al. 2001).

The experience from the Afromontane forests has demonstrated the importance of timber yields from plantations to provide for general lumber requirements so that high quality timber from native forests may be used for specialized local needs. While not within the terms of reference for the current management plan for the native forests, consideration of plantation timber has a major bearing on outcomes for conservation management. The further development of a plantation resource as part of the agricultural landscape remains an imperative within south-western Australia despite the inflated expectations of early yield predictions (Harper et al. 2001).

The management of Western Australia's forests has not fully accommodated the combination of local support and an integrated and continuing timber industry matched to local-scale production. There has not yet been a demonstration of whether support for the industry will continue despite the substantial reduction in resource allocation. If fewer mills still distant from the resource continue to provide (even more) limited employment opportunities and limited inputs into the immediately local economy, it is likely that the vested interests that Lane Poole (1920) sought to move beyond may still dominate the forest debate into the future.

Without a clear link between ecological sustainability and vibrant forest-associated communities (see Kelly 2000, Lockie 2003), pressure will continue to be applied for a further reduction in cut, leading to pressure for more protected areas and less State forest available for timber production. This has the potential to further disconnect local communities from the interactions between people, and timber that vibrant healthy forests can provide. Carlson (2003) demonstrated that well-organized groups of local forest resource users were able to successfully manage a forest resource over an extended period of time (over 120 years), in a study on boreal forest in Sweden. Further, he found that resource users that are closely connected to the resource system are in a better position to adapt to signals from the ecosystem than centralized State agencies. We argue that greater control of forest resources immediately local to associated towns would contribute to both support for continued timber production in State Forests and sustainability of the resource.

7 CONCLUSION

The experience from the Afromontane forests of the Southern Cape demonstrated that a transparent and auditable yield within local ecological limits in combination with an integrated small-scale local industry allows both long-term certainty and widespread public support for local logging of the resource. The new management plan for the Western Australian forests has achieved the substantial reductions in yield necessary to enable the development of diverse and sustainable forest-associated communities. A reexamination of the structure of the forest industry geared to sustainable local communities is the next phase in the long road to sustainability in south-western Australia's jarrah forests.

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REFERENCES

Anon 1961. *Handbook of Agricultural Statistics*. Pretoria: Department of Agriculture.

Beggs, B.J. 1982. *General working plan for State Forests in Western Australia. Working Plan No. 87 Part I.* Perth: Forests Department of Western Australia.

Bond, W. 1997. Fire. In: Cowling, R.M., Richardson, D.M. and Pierce, S.M. (eds). *Vegetation of Southern Africa.* Cambridge: Cambridge University Press: 421-446.

CALM. 1994. *Land and Forests Commission, Forest Management Plan 1994-2003.* Perth: Department of Conservation and Land Management.

Calver, M.C. and Wardell-Johnson, G. 2004. Sustained unsustainability? An evaluation of evidence for a history of overcutting in the jarrah forests of Western Australia and its consequences for fauna conservation. In: Lunney D (ed). *Conservation of Australia's Forest Fauna*, Chipping Norton, Surrey Beatty and Sons: X-X.

Carlson, L. 2003. The strategy of the commons: history and property rights in central Sweden. In: Berkes, F., Colding, J. and Folke, C. (eds). *Navigating Social-Ecological Systems*. Cambridge: Cambridge University Press: 116-131.

Christensen, P. 1973. Focus on a new concept in forestry – fauna Priority Areas. *Forest Focus*: 10: 3-10.

Clark, J. 2003. A new forest and wood industry framework for Australia. In: Lindenmayer D. B. and Franklin J. F. (eds). *Towards forest sustainability.* Collingwood: CSIRO Publishers: 189-203.

Conservation Commission of Western Australia. (2004). *Forest Management Plan 2004-2013*. Perth: Conservation Commission of Western Australia.

Day, A. and associates. 2002. *Draft Forest Management Plan: Supplementary Social and Economic Impacts Report*. Perth: Conservation Commission and Forest Products Commission.

Donald, D.G.M. and Theron, J.M. 1983. Temperate broad-leaved evergreen forests of Africa south of the Sahara. In: Ovington, J. D. (ed). *Temperate Broad-leaved Evergreen Forests.* Amsterdam: Elsevier: 135-68.

Forests Department of Western Australia, 1977. *Working plan no. 86 of 1977. Part 1*. Perth: Forests Department of Western Australia.

Goodland, R.J.A., Asibey, E. O. A., Post, J.C. and Dyson, M.B. 1990. Tropical moist forest management: the urgency of transition to sustainability. *Environmental Conservation* 17: 303-318.

Grut, M. 1965. *Forestry and Forest Industry in South Africa*. Cape Town: A.A. Balkema.

Harper, R.J., Mauger, G., Robinson, N., McGrath, J.F., Smettem, K.R.J., Bartle, J.R. and George, R. 2001. Manipulating catchment water balance using plantations and farm forestry: case studies from south-western Australia. In: Nambiar, E.K.S and Brown, A.G. (eds). *Plantations, Farm Forestry and Water*. RIRDC Publication no 1/20: 44-50.

Hatton, T. and George, R. 2001. The role of afforestation in managing dryland salinity. In: Nambiar, E.K.S and Brown, A.G. (eds). *Plantations, Farm Forestry and Water*. RIRDC Publication no 1/20: 28-35.

Heberle, G. 1997. Timber harvesting of Crown land in the south-west of Western Australia: an historical review with maps. *CALMScience* 2(3): 203-224.

Heddle, E.M., Havel, J.J. and Loneragan, O.W. 1980. Focus on northern jarrah forest conservation and recreation areas. *Forest Focus* 22: 3-29.

Hillborn. R. Walters, C.J. and Ludwig, D. 1995. Sustainable exploitation of renewable resources. *Annual Review of Ecology and Systematics* 26: 45-67.

Hoffman, M.T. 1997. Human impacts on vegetation. In: Cowling, R.M., Richardson, D.M. and Pierce S.M. (eds). *Vegetation of Southern Africa.* Cambridge: Cambridge University Press: 507-534.

Hopper, S.D. 2003. An evolutionary perspective on south-west Western Australian landscapes, biodiversity and fire: a review and management implications. In: Abbott, I and Burrows, N. (eds). *Fire in ecosystems of south-west Western Australia: Impacts and management*. Leiden: Backhuys: 9-35.

Kelly, G. 2000. *Rural communities adapting to change: case studies from southwestern Australia*. Unpublished PhD thesis, School of Psychology. Perth Curtin University of Technology.

Lane Poole, C.E. 1920. *Statement prepared for the British Empire Forestry Conference*, London, 1920. Perth: Government Printer.

Lockie, S. 2003. Conditions for building social capital and community well-being through plantation forestry. *Australian Forestry* 66: 24-29.

Ludwig, D. Hilborn, R. and Walters, C. 1993. Uncertainty, resource exploitation and conservation: lessons from history. *Science* 260: 17-20.

McCaw, W.L. and Hanstrum, B., 2003. Fire environment of Mediterranean south-west Western Australia. In: Abbott, I. and Burrows, N. (eds). *Fire in ecosystems of south-west Western Australia: impacts and management.* Leiden: Backhuys: 87-106.
McKenzie, N.L. Hopper, S.D. Wardell-Johnson, G. and Gibson, N. 1996. Assessing the conservation reserve system in the jarrah forest region. *Journal of the Royal Society of Western Australia* 79: 241-248.
Midgeley, J.J., Cowling, R. M., Seydack, A.H.W. and Van Wyk, G.F. 1997. Forest. In Cowling, R.M., Richardson, D.M. and Pierce, S.M. (eds). *Vegetation of Southern Africa.* Cambridge: Cambridge University Press: 278-299.
Ponting, C. 1991. *A Green History of the World*, Penguin Books, New York.
Rundle, G.E. 1996. History of conservation reserves in the south-west of Western Australia. *Journal of the Royal Society of Western Australia* 79: 225-240.
Seydack, A.H.W. 1995. An unconventional approach to timber yield regulation for multi-aged, multi-species forests. 1. Fundamental considerations. *Forest Ecology and Management* 77: 139-153.
Seydack, A.H.W. 2000. Theory and Practice of yield regulation systems for sustainable management of tropical and subtropical moist natural forests. In: Gadow, K.von, Pukkala, T. and Tome, M. (eds). *Sustainable Forest Management*. Dordrecht: Kluwer Academic Publishers: 257-317.
Seydack, A.H.W., Vermeulen, W.J., Heyns, H., Durrheim, G., Vermeulen, C., Willems, D., Ferguson, M, Huisamen, J. and Roth, J. 1995. An unconventional approach to timber yield regulation for multi-aged multispecies forests. 11 Application to a South African forest. *Forest Ecology and Management* 77: 155-168.
Stoneman, G.L. Hagan R.P. and Rayner M.E. 2005. Evolution of silvicultural practices in the jarrah forest of Western Australia. In: Calver, M. et al. (eds). *A Forest Conscienceness*, Amsterdam: Millpress.
Von Breitenbach, F. 1974. *Southern Cape Forests and trees*. Pretoria: The Government Printer.
Von Dem Bussche, G.H. 1975. Indigenous forest conservation management. *South African Forestry Journal.* 93: 25-31.
Wardell-Johnson, G. and Calver, M. 2004. Resolving historical sustainability in Western Australia's jarrah forests. In: Arianoutsou, M. and Papanastasis, V. (eds). *Ecology, Conservation and Management of Mediterranean Climate Ecosystems.* Rotterdam: Millpress:1-12.
Wardell-Johnson, G. and Horwitz, P. 1996. Conserving biodiversity and the recognition of heterogeneity in ancient landscapes: a case study from south-western Australia. *Forest Ecology and Management* 85: 219-238.
Wardell-Johnson, G. and Horwitz, P. 2000. The recognition of heterogeneity and restricted endemism in the management of forested ecosystems in south-western Australia. *Australian Forestry* 63 (3): 218-225.
Wardell-Johnson, G., Williams, J., Hill, K. and Cummings, R. 1997. Evolutionary biogeography and contemporary distribution of eucalypts. In: Williams, J. and Woinowski, J. (eds). *Eucalypt Ecology: Individuals to Ecosystems*. Cambridge: Cambridge University Press: 92-128.
Wardell-Johnson, G., Calver, M., Saunders, D., Conroy, S. and Jones, B. 2004. Why the integration of demographic and site-based studies of disturbance is essential for the conservation of jarrah forest fauna. In: Lunney D. (ed). Conservation of Australia's Forest Fauna. Chipping Norton: Surrey Beatty and Sons.
White, B.J. 1977. Focus on southern recreation and conservation management priority areas. *Forest Focus* 18: 3-23.
Whitmore, T.C. 1991. Tropical rain forest dynamics and its implications for management. In: Gomez-Pompa, A. Whitmore T.C. and Hadley M. (eds). *Rain Forest Regeneration and Management*. Man and Biosphere Series, Vol. 6. Paris: UNESCO/Parthenon: 67-89.