Chapter 11. Conclusions

Fuelwood has been the major form of home heating in southern New England since Europeans settled over 150 years ago. Regional consumption is estimated to be 31 000 $t.yr^{-1}$, of which the city of Armidale consumes 18 000 $t.yr^{-1}$. Over 80% of the town's supply is derived from dead trees on private land within 100 km. The principal species used are stringybark, yellow box and red gum, made available by land clearing and dieback. The most severe episode of dieback from the mid-1970s to the early-1980s destroyed millions of trees, and coincided with a doubling of domestic oil prices and the development of high-efficiency woodheaters. The proportion of urban wood users subsequently increased from 45% in the 1960s to 75% by 1990.

The severity of dieback and resultant rate of supply of dead trees has declined in recent years, possibly due to drought in the 1980s and 1990s. Evidence from public survey suggests that availability of dead timber has in turn declined, forcing suppliers and private collectors to travel further to find wood. Indiscriminate cutting along roadsides and unregulated extraction on private land is occurring in the absence of management. Armidale's industry functions on a 'cut and move on' basis and is unsustainable on a local scale because dead timber is being removed from paddocks in the absence of tree planting or natural regeneration (section 2.5.2). It is similar to Canberra's fuelwood industry which has been described by Morse (1985) as a 'mining operation'. About 65% of wood merchants and 57% of private collectors in Armidale acknowledge that fuelwood supply is diminishing.

Although no supporting data were sought in this study, evidence from local and overseas literature suggests that Armidale's fuelwood industry could be ecologically unsustainable in some parts of the region. Dead timber is an essential component of forest ecosystems, providing refugia for fauna and playing an important role in nutrient turnover. Removal of dead timber for firewood, evident along vegetated roadsides and larger remnant stands such as Eastwood State Forest, may reduce the abundance of ground-foraging birds and mammals, and arthropods dependent on rotting timber for habitat, with cascading ecological impacts on other trophic levels.

The main hypothesis of this thesis - that ecologically sustainable production of fuelwood on the Northern Tablelands is achievable through appropriate management of rural timber resources - is supported by results of a comprehensive resource inventory and a review of silvicultural and institutional practices. Two forestry options are appropriate for managing rural timber resources in southern New England: fuelwood forestry and fuelwood plantations (agroforestry).

Fuelwood forestry involves the manipulation of native forest for production of fuelwood and other products. A total estimated 31.7 Mt of standing fuelwood biomass exists within a 11 200 km^2 'fuelwood catchment' surrounding Armidale. Of this, about 2.4 Mt is considered suitable for fuelwood forestry based on the following selection criteria:

1. stands should comprise open or closed eucalypt forest (fuelwood extraction in woodland and stands of scattered and isolated trees should be avoided, particularly for urban supply).
2. stands should be located on private land or state forest (all roadside and TSR vegetation should be conserved in the region and fuelwood harvesting within them should be prohibited).
3. stands must be accessible to 2-wheel drive and truck (vehicle movement and fuelwood harvesting on steep or boggy terrain may cause erosion).
4. stands should be dominated by stringybark or box-gum species, preferably the former since they are more abundant (stands dominated by red ironbark or casuarina should not be cut for urban fuelwood).
5. stands should be at least 40 ha in area (disturbance attributed to fuelwood forestry may be magnified in smaller stands).

An estimated 2.39 Mt of suitable fuelwood forest occurs on private land (157 km^2) and 0.23 Mt occurs in state forests (15 km^2). Stand yield varies from 2-3 $t.ha^{-1}.yr^{-1}$ depending on site quality, and annual turnover is around 43 000 $t.yr^{-1}$, enough fuelwood to supply Armidale and rural surrounds in perpetuity.

Fuelwood forestry has a role to play in the conservation of biological resources on New England farms, in which the industry operates within an ecologically sustainable framework. Using a group-selection cutting regime based on 'coppice with standards', specific silvicultural guidelines are recommended for its achievement:

1. harvesting should be limited to 'fuelwood species' (stringybark, yellow box, red gum, grey box for urban and rural use; ironbark for rural use).
2. fuelwood trees should be selected within a DBH range of 15-60 cm (retain trees < 15 cm for advance growth, and > 60 cm for habitat value).
3. at least 25% of target trees should be left standing to maintain structural diversity, with emphasis on habitat trees, vigorous regrowth, and trees exhibiting fencewood or sawlog potential.
4. trees should not be cut within 20 m of a watercourse or wetland.
5. grazing and prescribed burning should be excluded.
6. dead fallen timber should be retained on the forest floor.
7. a minimum 50 years rotation is suggested, subject to long-term research.

Fuelwood plantations are an additional option for farm income and biological conservation, and should be integrated into farming systems using shelterbelts and woodlots (agroforestry). New England plantings dominated by *Acacia*, *Casuarina* and *Eucalyptus* yield up to 10 $t.ha^{-1}.yr^{-1}$ of fuelwood biomass after 20 years, with prospects of improved growth under intensive coppice management. A total of

2500 ha of native plantations could meet Armidale's long-term fuelwood demand while enhancing farm productivity, offsetting annual release of CO_2 from woodburning, and assisting the assemblage of habitat corridors to strengthen the wildlife value of the region's variegated landscape. Several recommendations are proposed for fuelwood-based agroforestry in the region:

1. native tree species (preferably indigenous to the area) should be selected for planting on well drained upper and midslopes.
2. various exotic species, non-local eucalypts, and casuarinas should be selected for areas in which local eucalypts have been severely affected by dieback (these areas often coincide with frosty valley floors exhibiting relatively poor drainage).
3. trees should be established adjacent to existing forest and woodland, offering the potential for natural pest control in plantations, and long-term expansion of regional forest cover.
4. remnant native stands and isolated trees should be incorporated into plantings, encouraging natural regeneration.
5. fuelwood production should be integrated with pastoralism by establishing shelterbelts and woodlots (multi-row shelterbelts can improve agricultural productivity under a system of fuelwood cutting).
6. fuelwood shelterbelts should be planted parallel to major watercourses to improve water quality and thus riparian environments.
7. large woodlots could be managed on a short-rotation coppice basis, while providing protection for stock in periods of extreme weather.

There are two major reasons why fuelwood is not actively replaced on the Northern Tablelands at present. Firstly, there is widely held community perception that dead trees are expendable and do not need replacing. This may reflect the traditional association between fuelwood supply and land clearing. Secondly, the price of a delivered 'tonne' of firewood ($65) is too low to encourage farm plantations for financial returns. This artificially low price partly reflects underweight loads (an average 0.75 t delivered for every 'tonne' ordered) which often comprise poor quality or inadequately dried timber. Community education and industry regulation are thus key ingredients for responsible management of Armidale's fuelwood resources, and must be considered in parallel with appropriate silviculture.

Community education should focus on the ecological role of dead timber, the importance of timber replacement through natural regeneration and reforestation, and the role of native forest stands and fuelwood plantations in meeting fuelwood demand. Public acceptance of these messages would facilitate responsible management of native vegetation on rural land, and would enhance opportunities for investment in plantation and forestry programs by improving timber royalties on rural land. Industry regulation should be based on a price-increase to at least $85 t^{-1} to reflect genuine-quantity loads, and preferably $100- $120.$t^{-1}$, depending on species and haulage distance, to enable reinvestment in fuelwood management and tree replacement. Prices could rise under a prudently planned voluntary system of merchant licensing, in which merchants meet the costs of load certification (quality and quantity), tree replacement, and product marketing. A business cooperative of licensed merchants

offering certified loads at \$100 to \$120.t^{-1} might, with innovative marketing, capture a significant proportion of the fuelwood market. Reduction in woodsmoke emissions is also possible if quality-assured timber is consumed.

Given realistic prices through industry regulation, and market acceptance, landholders, merchants and SFNSW could benefit financially from fuelwood forestry. Between 100-200 $t.ha^{-1}$ of fuelwood biomass is available in stringybark-dominated forest in southern New England. A 200 ha forest could produce up to 800 $t.yr^{-1}$ (worth \$80,000 gross assuming a fuelwood price of \$100 t^{-1}). Economic analyses also suggest that profits are achievable from fuelwood plantations if value-adding and marketing is performed by landholders, and if fuelwood price is at least \$85 t^{-1}. Profits are also possible under merchant-based operations at \$85 t^{-1}, and contractor-based operations at \$105 t^{-1}. Landholders could consider diversifying farm output should timber royalties improve.

Various institutional measures are suggested for fuelwood management in southern New England. These include the development of a regulatory agency, preferably under the auspices of SFNSW, to oversee technical aspects of fuelwood silviculture in native forests and plantations. A 'fuelwood forestry code of practice' should be drafted, outlining prescriptions with respect to harvesting and on-going management of fuelwood forests and agroforests. Community forestry should be investigated as a means to evoke a stewardship ethic towards fuelwood supply. A sewage-irrigated fuelwood plantation close to Armidale could be established to supply timber and raise community awareness of the fuelwood issue, whilst improving water quality in the Macleay River catchment. Debt-for-conservation swaps and various types of on-farm assistance schemes could be introduced to encourage on-farm production.

Addressing the fuelwood problem throughout southern New England not only ensures sustained supply for its population, but offers great scope for incorporating the larger issue of biological conservation in the rural landscape. Fuelwood forestry has a clear role to play in conservation biology and vice versa, and the two disciplines should be married if supply is to be guaranteed in an ecologically sustainable manner. Within a suitable silvicultural and institutional framework, the status of fuelwood management could be transformed from a poorly managed and possibly unsustainable industry into a well-structured, sustainable and financially attractive regional enterprise.

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