Land, Water & Wool
Northern Tablelands
Project Fact Sheet
9

Biodiversity and wool production—answers to The 10 Big Issues

A technical guide

Introduction

Early in the Land Water & Wool (LWW) Northern Tablelands Project (NSW), local woolgrowers developed a list of ten critical issues they wanted answered, about wool production and biodiversity. These ten issues are pivotal to profitable, biodiverse wool production in southern New England.

After 4 years of research, this Fact Sheet provides answers to the ten issues posed by woolgrowers.

1. Importance of native pastures to wool production

Native pastures are clearly lower input and lower cost than sown pastures. We surmised that native pastures would sustain greater plant diversity than sown pastures, as well as playing an important role in wool production.

To investigate these relationships, we sampled 107 pastures on 22 Monitor farms in 2004, at the same time as Monitor woolgrowers recorded their production. (For more details, see Fact Sheet 4.)

Do native pastures sustain a greater diversity of plants than sown pastures?

Answer: no—on basalt soils, the difference in total number of herbaceous species in sown and native pastures was not statistically significant (Fig. 1), despite the trend of more herbaceous plant species in native pastures.

However, there were more native species in native than sown pastures (Fig. 1). Naturalised pastures (sown pastures that had reverted to native dominance) had similar numbers of native and introduced species as never-cultivated native pastures.

The differences in numbers of introduced species in sown, naturalised and native pastures were not significant.

How do native and sown pastures compare, productivity-wise?

This question arose from the wide divergences in Monitor farms, from those which were all native to those that were almost all sown or naturalised (sown-reverted) pasture.

We answered this question by tallying

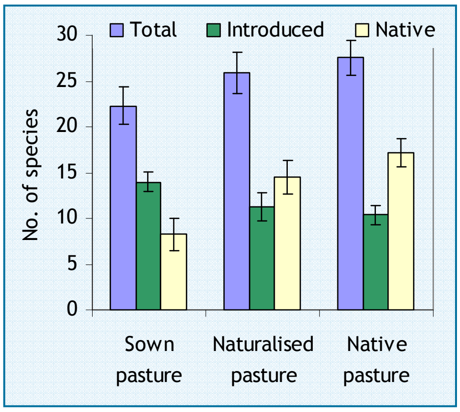

Figure 1. Average number of herbaceous species (total), introduced and native species in sown, naturalised and native pastures on basalt soils. Native pastures are defined as never-cultivated herbaceous vegetation with ≥ 50% cover of native species. The number of native species in sown pastures was significantly (ANOVA, $P < 0.05$) less than in naturalised and native pasture. The differences in total and introduced species between pasture types were not significant. Sample sizes: sown (n = 7), naturalised (8) and native (11) pasture.

up woolgrower records of sheep and cattle carrying capacities for each paddock. Monitor farmers attributed wool production documented in their wool returns to different flocks on each farm, and we attributed wool production to paddocks based on time spent by each flock per paddock.

Sown pastures ran most stock (sheep and cattle combined) in 2004 (Table 1). Stocking rates on native and naturalised pastures were lower, but not significantly so.

Conversely, the highest wool production (19 kg wool/ha) came from naturalised (sown-reverted) rather than sown pastures. Monitor farms ran a lower proportion of sheep and a higher proportion of cattle on sown pastures than other pasture types (Table 1). A greater proportion of young sheep were run on sown pastures than other pasture types, also contributing to the lower wool yield.

Open native (never-cultivated) pastures returned 14 kg wool/ha, while sown pastures and wooded native pastures (scattered trees and dense timber) ran about 4 sheep DSE/ha and produced 8-10 kg wool/ha (Table 1).

While native pasture species sustained a large amount of wool production, the most productive wool-producing

Above—Sown pastures such as this fescue, phalaris, white clover and plantain sward ran the highest stocking rates on Monitor farms in 2004. Photo—Jodie Reseigh.

Above—Naturalised (sown-reverted) pastures dominated by native species, such as this mix of redgrass, Parramatta grass and cocksfoot, produced the most wool on Monitor farms in 2004.

Above—Monitor woolgrowers ran a higher proportion of cattle and young sheep on sown pastures in 2004. Photo—Jodie Reseigh.

Above—A native pasture in scattered native timber. Photo—Jodie Reseigh.

pastures were sown pastures that had reverted to native dominance. So although native species were important, pasture sowing or renovation and the sown species that persisted in naturalised pastures were also integral to high wool production.

Local woolgrowers at a field day in June 2006 expressed surprise at the stocking rate and wool yield figures from sown pastures. It should be remembered that 2004 was a drought year. Conditions had started to deteriorate by the time pasture sampling was completed in May 2004. Monitor woolgrowers were managing their sown pastures gently in a difficult year, and preferentially running cattle and young sheep.

What are the most important forage plants in southern New England pastures?

Table 2 shows the range of sown and native species in naturalised pastures that underpin productivity. Persistent sown species in naturalised pastures include the year-long green phalaris and white clover. Naturalised pastures are also characterised by productive, volunteer native grasses, notably the summer-growing native lovegrasses (several species), redgrass, Parramatta grass and hairy panic.

During the research, some Case Study and Testimonial woolgrowers said that the mix of sown and native species in naturalised pastures was good for wool production because of the range of species for every season.

The year-long green poa tussock, and couch and crabgrass, which also volunteer in naturalised pastures, are not as productive, but form an important safety net. They provide persistent groundcover in case of overgrazing or drought.

In native (never-cultivated) pastures, the sown species are absent and poa tussock and redgrass-Parramatta grass pastures dominate in the open (Table 2). In native timber, hairy panic and some of the native lovegrasses decline in abundance, and microlaena and poa tussock dominate.

Table 1. Average livestock production figures for 64 paddocks on 18 Monitor farms from January to December 2004. Pasture attributes were confirmed by sampling vegetation in each paddock. Values in each row with a different superscript differ significantly (ANOVA, LSD, $P < 0.05$).

	Sown Pasture*	Natural-ised Pasture	Native Pasture	Scattered Trees**	Dense Timber ***	Remnant Timber ***
No. of sites	4	11	23	10	10	6
Wool yield (kg/ha)	9.5 ^{b,c}	18.6 ^{a}	13.8 ^{a,b}	8.1 ^{b,c}	9.5 ^{b,c}	1.4 ^{c}
Livestock carrying capacity (DSE/ha)	8.1 ^{a,b,c}	7.8 ^{a}	7.1 ^{a,b}	4.8 ^{b,c}	4.5 ^{c}	0.4 ^{d}
Sheep stocking rate (DSE/ha)	4.4 ^{a,b,c}	6.8 ^{a}	6.1 ^{a,b}	3.9 ^{a,b,c}	3.9 ^{b,c}	0.4 ^{d}
Cattle stocking rate (DSE/ha)	3.6 ^{a}	1.0 ^{b,c}	1.5 ^{b}	0.9 ^{b,c}	0.8 ^{b,c}	0.0 ^{c}
Wool production per head (kg/DSE)	2.4 ^{a}	2.8 ^{a}	2.6 ^{a}	2.0 ^{a}	2.6 ^{a}	0.6 ^{b}

** Two paddocks were excluded as they were recently sown and only lightly stocked in 2004.*
***Scattered trees had a projected foliage cover of trees < 10%.*
****Dense timber had a projected foliage cover of trees ≥ 10% and was commercially grazed; remnant timber occurred in paddocks managed for conservation but was occasionally grazed.*

Table 2. The average cover (%) of dominant plants in different pasture types on Monitor farms in March-May 2004. Plant species are ranked in terms of their contribution to sown pastures; shading indicates species that contributed >1.5% cover, on average. An asterisk indicates introduced species.

	Sown Pasture	Natural-ised Pasture	Native Pasture	Scattered Trees	Dense Timber
No. of sites	7	14	29	14	15
Meadow fescue (*Festuca pratensis*)*	16.0	1.9	0.0	0.1	1.1
Phalaris (*Phalaris aquatica*)*	15.3	4.9	0.5	0.2	0.0
Cocksfoot (*Dactylis glomerata*)*	7.1	1.0	0.2	0.9	0.1
Plantain (*Plantago lanceolata*)*	6.3	3.1	0.5	1.7	0.3
Couch (*Cynodon dactylon*)	4.3	5.2	4.4	8.6	3.9
White clover (*Trifolium repens*)*	3.6	2.4	1.2	0.5	0.6
Native lovegrass (*Eragrostis trachycarpa*)	3.1	6.5	3.7	2.3	0.2
Crab grass (*Eleusine tristachya*)*	2.4	5.5	3.7	1.2	0.0
Wallaby grass (*Austrodanthonia racemosa* var. *racemosa*)	1.3	1.6	2.4	3.9	2.7
Redgrass (*Bothriochloa macra*)	1.0	13.9	16.3	4.4	1.7
Hairy panic (*Panicum effusum*)	0.7	4.0	4.6	1.0	0.1
Paddock lovegrass (*Eragrostis leptostachya*)	0.7	3.5	5.4	0.9	0.2
Parramatta grass (*Sporobolus creber*)	0.4	4.5	7.4	3.0	0.4
Poa tussock (*Poa sieberiana*)	0.3	7.0	13.9	9.0	5.6
Microlaena (*Microlaena stipoides*)	0.1	0.5	2.9	21.1	24.7

2. Importance of grazing management

Strategic approaches to grazing management can increase the desirable species in a pasture. Monitor woolgrowers had different approaches to grazing management, which could be broadly grouped into continuous grazing, long rotations or short rotations. The short rotations were characterised by high intensity, short-duration grazing and long-rest periods, and included planned and cell grazing.

Does grazing management affect the number of pasture species?

Answer: no—generally, there was no difference in the number of pasture species between continuous grazing, long rotations or short rotations. For instance, there were no significant or consistent differences between continuous grazing, long rotations or short rotations in either native or introduced species richness in open pastures on basalt soils (Fig. 2).

Does grazing management affect the abundance of desirable pasture species for production?

Pasture cover was separated into four production categories: (1) desirable species, (2) species of intermediate value, (3) undesirable species and (4) woody plants. When these categories were analysed, no effect attributable to grazing management was detected in open pastures on basalt soils (Fig. 3), nor in uncultivated native pastures on all three soil types.

Does scale influence the effect of grazing management?

In pasture mosaics, different species dominate different patches whereas in a uniform pasture, the same composition occurs throughout. Measurements in a single size of plot may miss pasture mosaics at larger or finer scales. Pasture mosaics are desirable for growers who want individual paddocks to contain a wide variety of productive pasture species.

We examined the effects of grazing management on species richness of pastures at two scales: 30 m^2 and 0.9 m^2. No effect of grazing management on number of native, introduced or total species of pasture plant was detected at either scale.

Caveat—Given the gradual adoption of rotational grazing over the past 15 years, the effects are likely to be subtle on properties that have only recently changed. More research is warranted on properties with long histories of rotational grazing, where dramatic effects are expected.

3. Importance of litter and groundcover

Litter and groundcover are important for recycling of organic matter and nutrients in the topsoil, and protecting the soil surface from erosion. We surmised that increased levels of litter and groundcover would increase infiltration, soil moisture, and the diversity and biomass of soil biota.

To examine this question, the pasture verges of 35 dams and streams were sampled on 17 Monitor farms between November 2005 and January 2006 (see Fact Sheet 5 for details). Some areas were fenced and some were not, producing a variable range of pasture biomass (5-fold difference), pasture cover (69-97%) and litter cover (1-20%).

Do litter and groundcover affect infiltration and soil biodiversity?

Answer: yes—infiltration increased significantly with increasing litter cover (Fig. 4). The abundance of macro-invertebrates also increased significantly with increasing pasture cover. Ants, earthworms, spiders and scarab larvae—the soil engineers—all increased with increasing pasture cover (Table 3). Conversely, invertebrate numbers decreased with increasing amounts of bare ground (Pearson's correlation, r = -0.33, *P* = 0.05, n = 35).

So, across a wide range of farms and soil types, more litter means more rain getting into the soil and better water use efficiency. More pasture cover and less bare ground means more soil biota.

Note that when managing for conservation as opposed to production, bare ground is important for the germination of some native species.

4. Impact of topdressing with fertiliser and seed

Native pastures are often topdressed with fertiliser and seed in southern New England. We surmised that topdressing improves carrying capacity while retaining grazing-tolerant native species.

Does topdressing improve carrying capacity?

Answer: yes—Monitor farms ran twice as many livestock in topdressed native paddocks as in unfertilised, commercially grazed, native paddocks (Fig. 5a). Topdressed native paddocks also cut just over twice as much wool per hectare (Fig. 5b), although the differences were not statistically significant due to large variation.

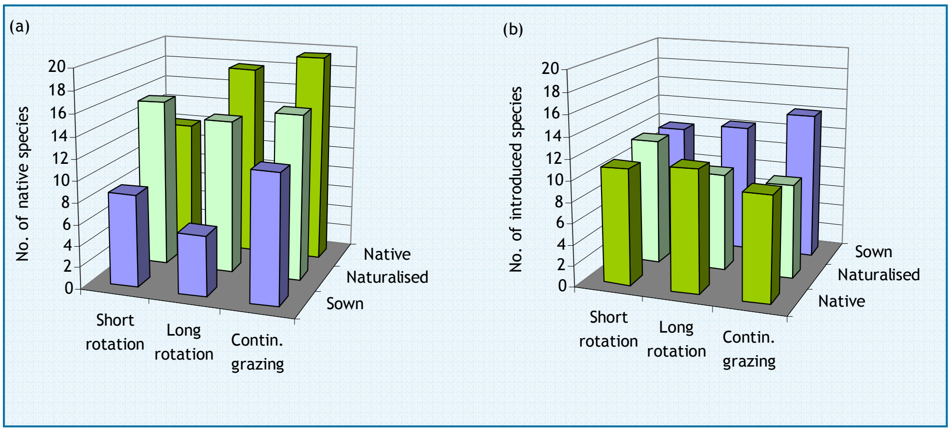

Figure 2. Average number of (a) native species and (b) introduced species in open pastures on basalt soils. Native species richness differed significantly between pasture types (Fig. 1) but, within each pasture type, grazing management had no effect on either native or introduced species richness (ANOVA).

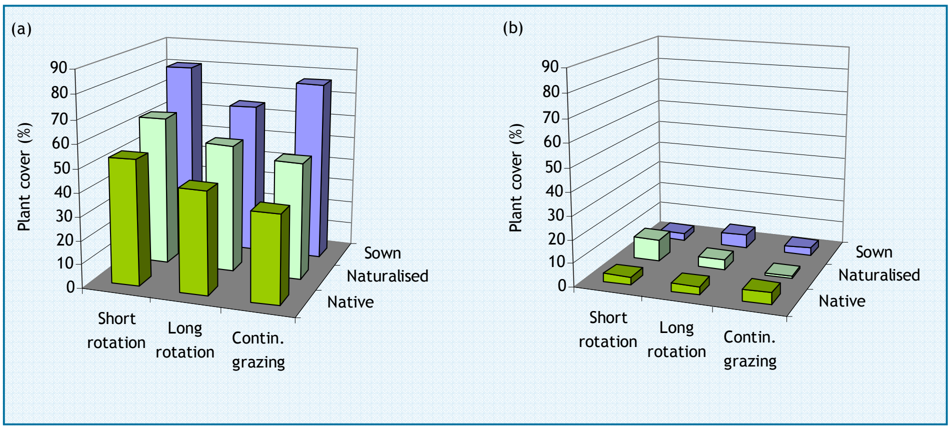

Figure 3. The average cover of (a) desirable and (b) undesirable herbaceous plants in open pasture types on basalt soils. The reduction in cover of desirable species from sown to native pastures was statistically significant (ANOVA, LSD, P = 0.05), but the effect of grazing management was not.

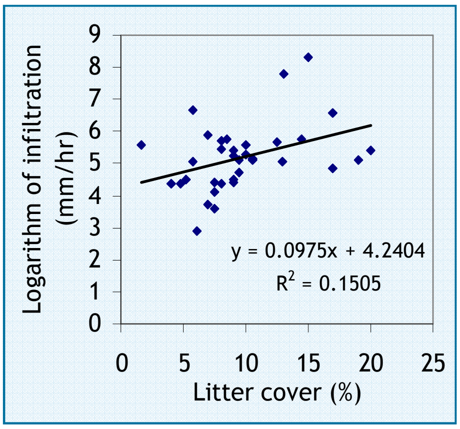

Figure 4. Relationship between infiltration and litter cover in dam and stream verges on Monitor farms (n = 35, P < 0.05).

Above—Plenty of litter and good levels of pasture biomass are important for high infiltration, biologically active soils and high rainfall use efficiency.

Table 3. Correlations between pasture cover (%) and invertebrate numbers in the topsoil in dam and stream verges on Monitor farms (n = 35). Pearson correlation coefficients (r) significant at P < 0.1 unless otherwise indicated.

	Total Inverteb-rates	Ants	Scarab Larvae	Earth-worms	Spiders
Pearson's correlation coefficient (r)	0.63***	0.45**	0.32	0.35	0.40*

* *P* < 0.05; ** *P* < 0.01; *** *P* < 0.001.

Does fertilised native pasture support fewer species than unfertilised native pasture?

Answer: yes—on granite and trap soils, there were more native pasture species in unfertilised than fertilised pastures (Fig. 6a), although the difference was only significant on granite soils.

The converse was true for introduced species. Unfertilised native pastures on trap and granite soils had fewer introduced species than fertilised pastures (Fig. 6b); on granite soils, the difference was only marginal.

Increased soil fertility and the increase in grazing pressure that accompanies fertiliser amendment favour a greater proportion of introduced than native herbaceous species on trap and granite soils.

5. Importance of establishing woody cover in open country

Planting trees and shrubs in open country is expensive and costs can exceed $5,000 per hectare, so it's not something to be taken on lightly.

Nevertheless, half of 347 woolgrowers in southern New England who responded to a 2003 survey (Fact Sheet 7) thought they had too little tree cover on their farms. This group of growers was planting 1250 trees each year. Extrapolating, woolgrowers were planting a total of 500 000 trees per annum on southern New England farms, at an annual cost of about $2.5 million.

Despite the high costs of tree planting, reforesting open paddocks and planting shelter for livestock is demonstrably profitable if it results in an increased lambing percentage of 10% and reduced mortality of sheep off-shears of 50% (Fact Sheet 8).

Does planting windbreaks across open country provide habitat for more fauna?

Answer: yes—the bird results (Fact Sheet 1) show greater numbers and varieties of insectivorous birds in planted windbreaks than in or over open pasture, meaning greater insect pest control in farmland than would otherwise be the case.

The Land, Water & Wool bird surveys were conducted in spring during the breeding season. Subsequent surveys in autumn on Harnham Landcare Group farms showed even greater use of planted windbreaks by birds outside the breeding season. Birds in planted windbreaks included some of the ten declining woodland birds that are headed for extinction further west in the cropping belt due to habitat loss.

Planted windbreaks also affected the species of bat in otherwise open country (Fact Sheet 2). Forest and woodland microbats ventured out along windbreaks, eating a wider variety of insects than the one species that commonly occurs over pasture.

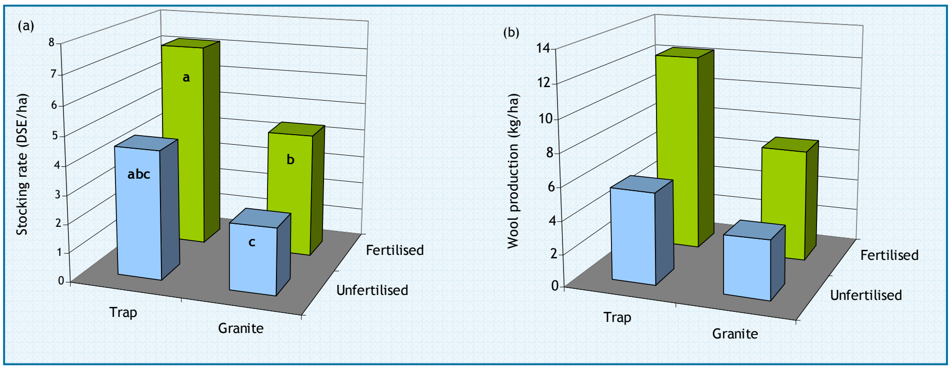

Figure 5. (a) Stocking rate and (b) wool production in relation to fertiliser and soil type in grazed, uncultivated native pastures on Monitor farms in 2004. Stocking rate was significantly affected by fertiliser (nested within soil type) (log-transformed data, ANOVA, $F = 4.69$, $df = 2, 28$, $P < 0.05$), but wool yield was not. Bars with different letters differ significantly (LSD, $P < 0.05$).

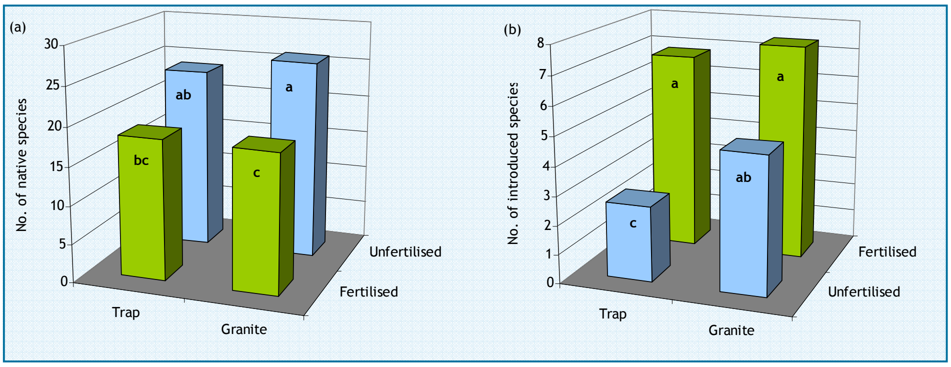

Figure 6. Average number of (a) native and (b) introduced pasture species in relation to soil type and fertiliser in never-cultivated paddocks on Monitor farms in 2004. Fertiliser (nested within soil type) significantly affected native (ANOVA, $F = 4.89$, $df = 2, 49$, $P = 0.05$) and introduced (ANOVA, $F = 5.64$, $df = 2, 49$, $P < 0.01$) species richness. Bars with different letters differ significantly (LSD, $P < 0.05$).

6 & 7. Do introduced plantings provide the same biodiversity benefits as native plantings?

Questions 6 and 7 concerned the difference between native and introduced tree and shrub plantings for biodiversity. We tackled this by studying the birds in detail on one Case Study farm, 'The Hill-East Oaks' at Kentucky, belonging to Jon and Vicki Taylor.

Jon and Vicki have planted a wide range of native and introduced trees and shrubs on 'The Hill'—some 400 000 trees—and to a lesser extent, 'East Oaks'. A little native timber (scattered trees and dense timber) remains on 'The Hill' and good stands occur at 'East Oaks'. Since the two blocks are only separated by 4 km, these properties provided a natural laboratory to answer the question.

Bird censuses were carried out at 'The Hill' and 'East Oaks' in December 2002. The results in Table 4 underscore the importance of timber to avian diversity, as found on Monitor farms (Fact Sheet 1). Very few species or individual birds were recorded in open pasture, in comparison to areas of planted or native timber.

Above—Extensive plantings of introduced trees provide shade and shelter for livestock, a potential source of income from timber and are important for habitat and connectivity for birds and other wildlife in woolscapes.

Above—Native timber provides shade and shelter for livestock as well as excellent wildlife habitat.

Do plantings of introduced trees and shrubs provide biodiversity benefits?

Answer: yes—planted areas of exotic and mixed exotic and native trees (windbreaks, agroforestry paddocks, and pine blocks) yielded 5-6 times more species and 7-8 times more birds, on average, than open pasture (Table 4).

Areas of scattered native trees over pasture and in the riparian zone mixed with planted exotic and native trees scored an average of 8 times more species and 11-14 times more individual birds than pasture.

The pines, poplars, oaks, cypress, and other species at 'The Hill-East Oaks' provide important habitat for some birds, including declining and vulnerable species. Plantings of introduced species are often dense, with dense foliage down to ground level, unlike the grazed grassy woodlands and scattered trees over pasture typical of grazing land locally.

Foliage density is important in providing habitat for species with specialised habitat and feeding requirements, such as the superb fairy-wren and white-browed scrub-wren. The density of introduced plantings also provides refuge from aggressive farmland species and predators such as noisy miners, pied currawongs, magpies and grey butcherbirds.

Young lines of eucalypts and small native trees mixed with taller pines in whole paddock plantings are important in providing shrubby native habitat for the white-eared honeyeater and white-throated warbler.

Extensive plantings of introduced species also increase the level of cover, shelter and connectivity for woodland species generally. Such plantings link sparse remnant tree cover for those species that require it, providing wooded corridors throughout the landscape.

Given that most of the 18% of timber cover on 'The Hill' is planted, and only a small percentage (2%) is remnant native timber, Jon and Vicki's reforestation activities have provided a much wider diversity of habitats and the bulk of the landscape connectivity for birds than would otherwise be the case. Half of the bird species at 'The Hill' are of special interest due to their declining or vulnerable status or their specialised habitat requirements (Fact Sheet 6).

Do native timber and native plantings provide greater biodiversity benefits?

Answer: yes—grazed native timber and planted native tree blocks returned 9-10 times more species and 16 times more individual birds, on average, than

Table 4. Species richness and abundance of birds in native and introduced tree plantings on birds at 'The Hill-East Oaks,' Kentucky, in December 2002. Birds were censused in 1.2 ha plots for 20 minutes; s.e.m. = standard error of the mean.

Habitat	Number of Transects	Number of Species			Number of Individuals	
		Average	s.e.m.	Range	Average	Range
Open pasture	7	0.9	0.5	0-3	1.4	0-5
Agroforestry*	2	4.5	1.5	3-6	11.0	4-18
Planted Pinus radiata blocks	2	5.0	2.0	3-7	10.5	6-15
Planted shelterbelt of introduced species	2	5.0	2.0	3-7	9.5	8-11
Riparian mixed plantings (with scattered native trees)**	4	7.0	2.2	3-13	14.8	9-25
Scattered native trees over pasture	5	7.0	1.7	3-13	19.6	6-33
Planted native blocks (with scattered native trees)	2	8.0	1.0	7-9	22.0	21-23
Grazed timber	5	9.0	1.1	5-12	21.8	10-36

**Whole paddock contour plantings of* Pinus radiata *and native species.*
*** Plantings of introduced and native species, and scattered remnant eucalypts*

pasture (Table 4). More species and individuals were recorded in areas dominated by native trees and shrubs or containing large old native eucalypts than introduced plantings.

However, any trees substantially increase avian diversity—both the variety and number of birds—several to many-fold compared to open pasture.

8. Importance of retaining native timber

We surmised that native timber would be important for both wool production and biodiversity. The Monitor farm data showed that wooded native pastures returned, on average, 8-10 kg wool/ha and ran 4-5 DSE/ha (mostly sheep) (Table 1). This was about half the contribution of naturalised pastures to wool production.

Does native timber provide important habitat for fauna and flora?

Answer: yes—native timber provides habitat for declining woodland birds, bats and arboreal marsupials such as brushtail and ringtail possums, koalas and sugar gliders on New England wool properties (Fact Sheets 1-3 & 6).

Good numbers of species and individual woodland birds were found in native timber on Monitor farms, including riparian timber.

Ten declining woodland bird species were recorded on Monitor farms and these mainly occurred in native timber (Fact Sheets 1 & 6). These species are headed for extinction in the cropping belt on the inland plains of NSW, due to excessive habitat clearance. Brushtail possums were found in over 80% of timbered areas, and koalas and sugar gliders in 20% (Fact Sheet 3). Bats were also in highest numbers and highest diversity in timber, especially riparian timber on wool properties (Fact Sheet 3). From a fauna viewpoint, the biodiversity value of timber is indisputable.

Native timber is also important for flora. Dense timber hasn't been cultivated, and will generally have received less fertiliser and grazing than cleared and thinned pastures. Thus, grazing-sensitive plants are more likely in timber than elsewhere on wool properties.

9. Conservative grazing management of the riparian zone

We surmised that conservative grazing management in the riparian zone would be important for both wool production and biodiversity.

Several Testimonial and Case Study woolgrowers manage parts or all of their riparian zones conservatively for improved water quality, pasture production and shelter. See all three Case Studies and various Testimonials prepared by the Project. In these products, local woolgrowers explain why they manage sections of creeks and streams differently from the rest of their properties, or in a manner that is conservative and protective of soil, water and vegetation.

Are riparian habitats important for fauna?

Answer: yes—we found riparian zones

Above—Conservative grazing management in the vicinity of streams leads to good water quality for livestock and important aquatic habitat for wildlife.

Table 6. Water quality measurements in paired fenced and unfenced dams on Harnham Landcare Group farms in autumn 2003. Data are average values for four pairs of dams. An asterisk indicates the values differed significantly (Paired t-test, df = 3, P < 0.05; SRP values were log-transformed for analysis).

Variable	Fenced	Un-fenced
pH	8.3	7.5*
Soluble reactive phosphorus (mg/L)	0.025	0.103*
Nitrate-nitrite oxides (mg/L)	0.174	0.004
Turbidity (NTU)	41.2	52.7
Electrical conductivity (µS/cm)	268	146*

have special natural values, as well as being important for livestock water and production and catchment health. Riparian woodland was one of the habitats targeted in fauna surveys on Monitor and Case Study farms. Of all the habitats sampled, riparian woodland (projected foliage cover of trees 10-30%) had the largest numbers and the most species of birds and bats (Fact Sheets 1 & 2).

10. Is it worth fencing off farm dams?

We surmised that fencing off farm dams from livestock or restricting access for much of the time would increase pasture biomass around the dam verge, improve dam water quality, increase aquatic vegetation in dams, and increase aquatic animal life.

This question was examined at 27 dams on 17 Monitor farms between November 2005 and January 2006. Ten dams were fenced although a couple of these were grazed for a small proportion of the year; the rest were unfenced. Wherever possible, paired fenced and unfenced dams were sampled on each property (Fact Sheet 5).

Does fencing improve water quality filtering capacity?

Answer: yes—fencing led to a significant increase in pasture biomass. Despite occasional grazing in some fenced dams, unfenced dams had an average pasture biomass of 2.4 t dry matter/ha, compared to fenced dams with 3.4 t DM/ha. There was more water filtering capacity in the form of dense pasture around fenced dams.

Does fencing dams improve water quality?

Answer: sometimes! Measurements did not show better quality in fenced dams in early summer in 2005-06 due to a brief 3-month wet period (Fact Sheet 5). Heavy rain and substantial runoff equalised water quality temporarily throughout the district.

However, in earlier work on Harnham Landcare Group farms in autumn 2003, soluble reactive phosphorus (SRP) was higher in unfenced than paired fenced dams (Table 6). This was presumably from the dung and urine of livestock in unfenced dams.

Are fenced dams good for biodiversity?

Answer: yes—fencing was significantly related to the amount of aquatic vegetation in dams. More emergent and submergent aquatic vegetation occurred, and there was less open water in fenced dams.

The number of waterbird species was also higher on fenced than unfenced dams. However, fenced dams were larger than unfenced dams on the same properties. So the larger number of waterbird species was probably also due to the effect of dam size. There were larger numbers of waterbirds on larger dams, as well as more species.

Conclusions

Southern New England wool properties are biodiverse places, with many natural values as well as productive assets (soil, water, vegetation and beneficial organisms).

The production data collected by Monitor woolgrowers in 2004 showed that pastures dominated by native species and wooded native pastures produced the bulk of the superfine wool for which the regional industry is famous. Sown pastures in 2004 were managed more for meat production and growing out young stock.

Economic analysis undertaken by the LWW Northern Tablelands Project underscored the importance of shade and shelter and revegetation for livestock survival and improved farm profits (Fact Sheet 8). The native timber and planted woody vegetation which is so important for livestock production is also valuable for native fauna. These fauna provide ecosystem services on farm such as natural pest control by birds and microbats.

The project demonstrated ways in which conservative grazing management near water sources (streams and farm dams) can improve water quality for livestock and aquatic ecosystem health at the same time.

The many ways in which southern New England woolgrowers are managing their farms for both profitable and positive environmental outcomes are documented in the wide range of extension products developed by the LWW Northern Tablelands Project .

Land, Water & Wool (LWW) is the most comprehensive natural resource management research and development program ever undertaken for the Australian wool industry. LWW is a partnership between Australian Wool Innovation Limited and Land & Water Australia, and has seven core sub-programs. The Native Vegetation and Biodiversity sub-program is working with woolgrowers, and demonstrating that biodiversity has a range of values, can add wealth to the farm business and can be managed as part of a productive and profitable commercial wool enterprise.

The Land, Water & Wool Northern Tablelands Project is led by Associate Professor Nick Reid, University of New England, in collaboration with Southern New England Landcare Ltd, and the Centre for Agricultural and Regional Economics.

Acknowledgements—The Project Team is indebted to the Steering Committee of woolgrower families and advisers who prioritised the research questions addressed in this Fact Sheet. We thank the Monitor woolgrowers who allowed us to work on their farms, the Case Study and Testimonial woolgrowers for their participation and invaluable information, and Jann Williams, Mike Wagg, Renelle Jeffrey and Jane Thomas for commenting on drafts.

Author—Nick Reid.
Editing & design—Kàren Zirkler.
Photographs—Nick Reid unless otherwise stated.
Date—December 2006.

For more information, contact

- **Southern New England Landcare**
  PO Box 75A, Armidale, NSW 2350.
  Telephone 02 6772 9123
  Facsimile 02 6771 2656
  Email mail@snelcc.org.au

- **Associate Professor Nick Reid**
  Ecosystem Management, University of New England, Armidale NSW 2351.
  Telephone 02 6773 2539
  Facsimile 02 6773 2769
  Email nrei3@une.edu.au

- **www.landwaterwool.gov.au**