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Planting trees for biodiversity

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Biodiversity (biological diversity) may be defined as: 'The diversity of life on earth, consisting of the variety of species, the variety of genes, and the variety of communities or ecosystems'. Biodiversity encompasses the complete range of life forms from the most obvious to the least obvious (many of which remain unknown to science) (NSW Biodiversity Strategy – Discussion Paper, NSW DPI and DECC, 2008).

Species have an intrinsic right to exist for their own sake. Additionally, ecosystems and their associated diversity of species provide many 'goods and services' to humanity. Examples are:

Goods: food, pharmaceuticals, raw materials (e.g. fibre, timber, dyes, waxes, oil), fuel, plant and animal genetic resources.

Services: Detoxification and decomposition of waste, air and water purification, pollination, nutrient cycling, pest control, riverbank and coastal stability, regulation of the hydrological cycle.

The value of biodiversity is increasing as the costs involved in trying to reproduce these services are realised. In the case of New York City's water supply, it was found to be much cheaper to restore the natural catchments to supply clean water than it would have been to artificially filter it (Stapleton 1997). We also derive many less tangible but important benefits from ecosystems, such as recreation, aesthetic pleasure, interest provided by other species, physical and mental well being, and cultural/spiritual enhancement.

Vegetation management basics for biodiversity on farms

In order to maintain or increase the diversity of native animals, particularly birds (and plants) on a

farm, there are important rules of thumb for vegetation management.

1. **Maintain natural vegetation intact as far as possible.** This may range from existing large blocks, to smaller blocks and degraded blocks, to single mature paddock trees or patches of shrubs. Paddock trees are often an important contributor of tree hollows on farms. 'Bigger is better' for natural vegetation blocks, but even the smaller patches may be valuable for maintaining some biodiversity. Some wildlife species are restricted to mature natural forests or woodland, and these plant communities form a 'reservoir' for many more species to colonise man-made habitats.
2. **Tree planting or encouragement of natural regeneration should be targeted preferentially to augment existing natural habitat.** Allowing areas adjacent to intact natural vegetation to regenerate is often the best option. Planting of locally-occurring trees and shrubs in these zones is the next best alternative. This will expand the area of useful habitat in the longer term, and should help to build up populations of some wildlife, and allow dispersal. Planting non-local Australian trees or shrubs may still be useful.
3. **Plantings should target creek lines and gullies.** Many species are more abundant in gullies compared with ridges. Inclusion of a dam is beneficial to frogs, bats, and other groups of animals. Restoration of stream bank (riparian) zones is a high priority area for conservation.
4. **Make natural and/or planted vegetation patches as large as feasible.** Patches at least 5–10 ha in area, and compact in shape rather than linear, are more useful to wildlife.
5. **Planted or natural corridors are desirable, especially if they connect larger vegetation patches.** Corridors alone will not aid significantly in conserving declining animal species. Expanding core areas of remnant

natural vegetation is a greater conservation imperative. Corridors should ideally be at least 40–50 m wide, though narrower ones are still useful to some wildlife. Narrow linear plantings with a large edge-to-area ratio may be colonised by aggressive birds like Noisy Miners, to the detriment of smaller bird species.

6. **Leave fallen trees, branches and other ground debris in vegetated areas to decompose naturally – ‘messiness’ is key to increasing biodiversity.** ‘Messiness’ on the ground greatly raises the value of an area for wildlife. This cover is vital habitat for many reptiles, small mammals, and some birds. It also includes grass tussocks and small shrubs.
7. **Avoid high impact land uses, including grazing, in vegetated sections.** Grazing removes ground cover that provides important shelter for many species. Limited seed and firewood collection and honey harvest are acceptable.
8. **Consider planting a variety of tree densities.** A mixture of densities is likely to attract a variety of wildlife. Insectivorous bats preferentially use more open plantings.

(Adapted from Barrett 2000, based on results of 5 years of ‘Birds on Farms’ surveys on 330 properties; and Kavanagh et al. (2005), based on fauna surveys at 120 locations.)



Red-capped Robin – a woodland bird frequently seen in young eucalypt plantations. (Photo: M. Stanton)

The value of plantations for animal biodiversity

Only limited scientific research has been carried out in Australia on the role of tree plantations in restoring habitat for biodiversity. A study conducted by I&I NSW on the ‘Biodiversity in eucalypt plantings established to reduce salinity’ found that eucalypt plantations had much greater faunal biodiversity compared to cleared paddocks. Birds and bats appear to be the main animal groups that benefit from plantations, due to their greater mobility. In a study of 120 sites near Albury, NSW by Kavanagh *et al.* (2007), 30 species of birds were found in mostly cleared paddocks, compared with 95 in woodland remnants, and 87 in eucalypt plantations. Older plantings (10–25 years) had more birds than young (less than 10 years) plantings.

Larger patches (more than 5–20 ha) of both woodland remnants and eucalypt plantings had more bird species and individuals than smaller patches. Areas larger than 5 ha are significantly more useful to birds and other animals than are smaller areas. Eucalypt plantings (especially older age patches) provide habitat for many bird species classified as woodland-dependent, including some declining species. It should be realised, however, that while plantations provide suitable foraging habitat for many bird species, they do not provide suitable breeding habitat for hollow-nesters (see below).

Planting native trees and shrubs near remnant vegetation is more likely to attract wildlife than plantings established further away.

Arboreal marsupials, which are highly dependent on native forest or woodland remnants, are known to utilise eucalypt plantings adjacent to the remnants. Many species of bats also utilise plantations, at least for foraging, and bat activity is unaffected by plantation or remnant patch size (Law and Chidel 2006).

Enhancing wildlife habitats in plantations

Plantation ‘spectrum’

Trees may be planted on farms for many purposes, ranging from purely commercial to the creation of wildlife habitat. Where the prime purpose is to make money from wood products, species planted are often (but not always) exotic, e.g. pines or non-local native species. Normally a single species is planted over large areas. The ground is kept fairly clear for access and fire prevention, and deliberately grazed under agroforestry systems. The trees themselves may be clear-felled after 10 to 40 years. Such stands only have a short-term value for wildlife, but as part of a landscape mosaic including remnant forest and paddock trees, they can make an important contribution to conservation.

Plantings for environmental purposes (biodiversity, carbon sequestration, salinity control) tend to be retained for longer periods, perhaps with some wood harvesting. These give more scope than commercial plantations for habitat enhancement. In plantings intended mainly or entirely for wildlife conservation, there are many ways to improve habitat quality.

Natural and artificial hollows

Reduced biodiversity in eucalypt plantations compared with natural forest is due largely to the lack of hollows in stems and branches. These may take 150 years or more to form naturally, so plantations are of limited use to groups of animals (including mammals and birds) that nest or den in tree hollows.

Plantings that encompass remnant hollow-bearing paddock trees, or those adjoining mature natural forest, provide suitable habitat and breeding opportunities for a wider range of species than plantings without old trees. Animals may nest in the older trees and feed in the younger stand.

In many countries, artificial 'hollows' in the form of nest boxes are widely employed in forests without hollow trees. These nest boxes are utilised for breeding by birds including owls, tits and flycatchers. Nest boxes are not yet used widely in Australia, though there are several recent projects providing boxes specifically for black cockatoos in several States. In New South Wales, nest boxes placed in young (under 10-year-old) plantations on the north-west slopes since 2008 have been used by a range of animals, mainly for shelter. These include bats, glider possums, birds, lizards, frogs, and invertebrates. Parrots such as the Eastern Rosella nested in some boxes only two months after they were installed. It is evident at this early stage that the boxes are attracting more species into the plantations than would be there otherwise.

Nest boxes are a potentially useful tool to increase biodiversity in a range of plantation types, including commercial plantations of native species. However, they are likely to be more effective in conjunction with other habitat enhancement methods.

Ground debris

Reptiles, many small mammals and ground-dwelling or ground-feeding birds are usually absent from plantations, due to a lack of ground cover or shelter in the form of large woody debris or rock. This is normally cleared prior to planting, particularly in commercial plantations but, in environmental plantings, ground debris should be encouraged as part of a wildlife-friendly 'messiness'. Artificial provision of ground shelter by the landowner, in the

form of logs, flat rocks, or even sheets of tin or wood, will assist reptiles and native small mammals



Sugar glider using a nest-box in a eucalypt plantation on the Liverpool Plains near Quirindi (Photo M. Stanton)

to occupy plantations. Reptiles have been observed to find such artificial shelter even in fairly isolated plantings. A wider range of birds and small mammals may also appear, especially if the plantation is near larger areas of natural vegetation.

Maintaining existing ground debris and rocks in commercially-oriented plantations is problematic, although some could be retained in windrows. Artificial debris, such as sheets of tin or flat wooden boards, can be provided in the shorter-term.

Understorey plants

The diversity of native animal life in a plantation will increase significantly if an understorey of shrubs and small trees develops naturally or is planted. This provides extra opportunities for foraging, nesting, and shelter. The existence of multiple plant species and 'layers' is a major contributor to bird species richness. Selecting plant species appropriate to the site, preferably local endemic species, with complementary flowering patterns (flowering at different seasons), should give the best results. Growing shrubs in clumps is useful to attract many small birds including honeyeaters and fairy wrens. However, large-flowered shrubs in small or narrow plantings attract aggressive resident honeyeaters like Noisy Miners, which could dominate and exclude other species.

Planting native shrubs, such as the nitrogen-fixing acacias, could play an important role in enhancing growth of commercial plantations – although this might increase fire risk in large plantations. For plantations without shrubs, opportunities remain to plant shrubs in adjacent buffer zones. In shrub-free plantations, even allowing grass to grow freely will enhance their usefulness for wildlife. Keeping grass short or absent by grazing reduces potential biodiversity. Ground vegetation is habitat for insects, spiders, and small reptiles, which provide food for many birds.

Locating plantings close to water sources (creeks, dams, etc.) will often enhance their usefulness to wildlife, especially in dry times. Grazing should be excluded from some water sources, to allow them to develop aquatic and bank vegetation required particularly by frogs.

Tree diversity

Staggered age classes of plantation can increase diversity by providing a wider range of habitats. They can also buffer adjacent natural bush against edge effects such as fertiliser or spray drift, and weed infestation. Biodiversity will generally increase as plantings become older, especially if there is a developing understorey.

Animals rely on a wide variety of food resources provided by plants. Planting a variety of trees and shrubs that have complementary patterns of flowering and bark shedding helps to provide a year-round food supply, especially in winter when food is limited. Winter-flowering trees such as ironbarks and spotted gums provide nectar for various honeyeaters and lorikeets. Glider possums, including the threatened Squirrel Glider, and flying foxes (also classed as threatened species) feed on blossom in coastal blackbutt plantations. Several



Squirrel Glider feeding in blossom of plantation blackbutt (Photo: A. Towerton)

tree species favoured by flying foxes have been extensively cleared in NSW and can be planted to aid these animals. These are listed by region in Law *et al.* (2002), including box eucalypts on slopes and tablelands and a wider variety on the coast, notably forest red gum, swamp mahogany, and coast banksia.

Treecreepers, shrike-tits and many honeyeaters feed on insects and spiders that live under hanging bark ribbons on some eucalypts. Sittellas are small forest birds which feed and nest on dead wood in older trees. Flowers, loose bark, and dead wood increase as trees age.

Planting of other native trees, such as paperbarks, she-oaks and banksias, can increase and diversify food resources for wildlife. For example, bronzewing pigeons feed on fallen seed of wattles, and Sugar Gliders feed on wattle sap. Melaleucas flower prolifically, attracting many birds and flying foxes. White cypress pines provide daytime shelter for Koalas and important nest sites for babblers.



Western Gerygones (Warblers) will nest in young plantations (Photo: M. Stanton)

Protecting environmental plantings

Ensure that remnant native vegetation, paddock trees, and plantings are not damaged during farm or plantation operations. It is advisable to inform contractors of sensitive and 'no go' areas. Simple management plans and maps showing natural bush and planted areas are useful. Fencing is needed to keep stock out of young plantings and natural regeneration, at least until the plants are well established. Thereafter, in areas of vegetation managed primarily for conservation, stock grazing should be excluded or minimised.

Examples of properties where tree and shrub planting has benefited biodiversity

1. 'Red Braes', Quirindi, NSW

This property of 1435 ha, owned by Jim and Katrina McDonald, is located on the NSW North-West Plains. It is in a rich cropping and grazing region where native vegetation has been extensively cleared except on a few ridges with poorer soil. In 2001–2002, various parts of the property totalling about 40 ha were planted with river red gum, ironbark, Pilliga box, and spotted gum. Surveys of birds were carried out on the site of the largest patch of plantation (23 ha on a ridge top and upper slope) before and after planting. In this patch, which is very isolated from the nearest remnant vegetation, at least six open country bird species were known to occur before planting, but more than 54 species were recorded in the plantation by seven years of age. These included a wide range of forest bird species, except for those that rely on tree hollows for breeding.



Aerial view of 'Red Braes' hill plantings, 2006 (Google Earth)



Red Ironbark plantation on the ridge top at 'Red Braes' (Photo: R. Kavanagh)

2. 'Lanark', Branhholme, Victoria

Prior to 1967 the 800 ha property 'Lanark', like most of the surrounding landscape, was nearly devoid of natural vegetation, and wetlands had long been drained. Over the next 30 years, in an intensive program of farm forestry and revegetation, the owners (John and Cicely Fenton) planted over 80,000 trees and shrubs in shelterbelts, plantations and woodlands, using species endemic to the local area, and restored the wetlands. About 11% of the property was revegetated by 1996. The total number of native bird species on Lanark increased from fewer than 40 species in 1954 to 155 species in 1996. These included most of the species estimated to have been present in the region in pre-European times, except for some hollow-nesters. The return of these species was gradual, in many cases over 30 years, and was delayed in some cases until linkages were established between the plantings. Shrubs planted adjacent to plantation areas encouraged birds to forage in the plantations, including exotic tree species such as *Pinus radiata* (O'Neill 1999). A population of the endangered Eastern Barred Bandicoot was also established by re-introduction in the woodland areas of 'Lanark' and prospered, with the aid of fox and cat shooting and baiting, until persistent drought began in about 2000. Since then the bandicoot has been killed off by these feral animals at 'Lanark' and other unfenced sites in the district, but is surviving in fenced-off sites.



Aerial view of 'Lanark', 2005 (Google Earth)

Biodiversity plantings may enhance farm productivity

Increasing vegetation cover on a farm, to enhance biodiversity and for other purposes, is likely to lead to higher productivity of commercial products, apart from those generated by the trees themselves.

Insect control by birds and bats

There are few quantitative data on the impact that birds have on insect populations; however, it is thought to be significant. Many of the birds associated with Australian tree plantings are insectivorous. The owners of 'Danengate' near Hamilton in Victoria concluded that revegetation activities resulted in improved biological control of insects on pastures and trees, due to increasing populations of insectivorous birds. In the USA, birds can eat up to 98% of spruce budworms and as much as 40% of non-outbreak insects (those without periodic population explosions) in eastern forests, and can lower the population peaks when insect outbreaks do occur (Smithsonian National Zoological Park, undated). Insectivorous bats are also likely to be an important agent of insect control, eating up to 75% of their body weight per day. Bats require tree hollows for nesting and daytime roosting. Birds and bats play a key role in integrated pest management (IPM), which aims to reduce dependence on chemical insecticides.

Shelter for stock and crops – effects of windbreaks

While more wildlife species occur in larger plantation patches, even narrow shelterbelts provide habitat for some birds, and they are used by a number of bat species, many of which like flying along vegetation edges. Shelterbelts can be planted to connect larger habitat areas and may also provide shelter for livestock and crops. Mixed plantings, including shrubs or small bushy trees, help to fill gaps and reduce strong wind channels that can occur in narrow shelterbelts. Mixed species plantings (preferably of local native species) are also more likely to regenerate naturally, are less prone to outbreaks of pests and disease, and are likely to encourage greater biodiversity.



Southern Forest Bat and Little Forest Bat (Photo: B. Law)

The maximum protection provided by a shelterbelt is achieved by aligning the shelterbelt at right angles to the prevailing wind. As a guide the width

of land protected by a shelterbelt is approximately 20 times the height of trees in the belt. Longer shelterbelts are more effective than shorter ones which tend to channel the wind sideways around the edges (NPWS 1999).

On both 'Lanark' and 'Danengate', losses of newly-born lambs in cold weather fell greatly as shelter provided by tree belts and plantations developed. In South Australia, shelterbelts have been found to increase citrus yields by about 15% and also growth of citrus tree canopies. In Western Australia, tree belts reduce sand-blasting of wheat in some seasons, considerably increasing yields, and can reduce evaporation from farm dams.

Protecting waterways – riparian buffer strips

Existing natural, regenerated or planted vegetation along waterways is particularly valuable as wildlife habitat and as corridors facilitating animal movement between larger patches of habitat. Riparian strips have other important benefits such as protecting the waterways from excessive sediment and nutrients, and protecting the banks from erosion. Vegetation acts as a filter, trapping sediments and reducing pollution of the water from sprays and fertilisers.



Restored lake and plantings at 'Lanark', 1992 (Photography by Lindsay Stepanow; photo supplied by Thomson Hay & Associates)

There is no fixed prescription for buffer strip width. In terms of water quality, it is determined rather by the volume of water and sediment that is being transported. This in turn is determined by the soil type, slope, existing vegetation cover, land use (e.g. compaction by stock) or vehicle tracks. For wildlife, wider strips are more useful than narrow strips, and widths of 50 m or more (particularly of existing native vegetation) on either side of a stream have been recommended (Barrett 2000).

Planting advice for environmental plantings

Environmental plantings are characterised by a wider range of tree and shrub species than is the case in commercial plantations. Methods for commercial plantations are described in a separate I&I NSW publication on farm forestry.

Planting trees at wider than normal (commercial) and irregular spacings can be used to encourage the development of a natural shrub layer (where the potential exists for this to form) or the growth of a planted understorey. Some clumping of trees with more open areas in between mimics the structure of natural woodland. In environmental plantings, existing ground debris, logs, rocks, and paddock trees should be retained.

Riparian plantings

It is important to stabilise any stream banks in danger of collapse before revegetation of these banks is attempted.

Longstem tube stock of native trees or shrubs, grown in similar containers to normal tube stock, are useful for planting in stream banks, especially where there is a danger of floods washing away conventional seedlings. Longstem stock are 1–1.5 m tall, and are planted deeply into the bank with about three-quarters of the length buried, giving greater access to soil water. Pre-digging of planting holes using an auger is usually necessary. Deeply immersing the plants below the soil surface has not been found to result in disease on the stems (Hicks 2002).

Planted or regenerating vegetation in a riparian buffer strip needs to be protected from stock grazing or damaging animal browsing, at least during the establishment phase, by fencing and pest animal control (rabbits, hares etc.).



School children planting trees on a riverbank. Photo from I&I NSW Image Library.

Direct seeding

The information below is mostly from Border Rivers–Gwydir CMA (2009) and Lachlan CMA (2006).

Direct seeding refers to the sowing of seeds directly into the soil on a revegetation site. This method may be effective in establishing species for which seed is abundant and known to germinate well. It is likely to work best with local native species as they are adapted to grow in the area. It can be useful especially for mixed shrub species, and is suited to revegetating areas for wildlife habitat and shelterbelts.

Direct seeding can be used on low fertility or unimproved soils with little site preparation (soils not fertilised and with no introduced perennials and few annual weeds). Pasture-improved or high fertility areas require a very high level of weed control before direct seeding. Failing this, such areas may be best planted with containerised seedlings. Rabbits or hares near the planting area should also be controlled before sowing, and the area should be fenced if possible.

Waterlogged sites should be avoided for direct seeding. If they are to be planted, they will probably require mounding and planting of seedlings, using moisture-loving species such as *Melaleucas* (paperbarks), *Callistemons* (bottlebrushes), or swamp mahogany. In wet streamside areas with few weeds, natural species such as tea-tree could be grown by placing seed-containing branches on the ground (brush matting) which will protect the seedlings from the weather. Rocky and steep areas are unsuitable for machinery, but limited areas of this type can be seeded by hand.

Thorough weed control on the seed bed, using knockdown chemicals, is critical over the 12 months prior to planned seeding. This applies whether the mode of soil cultivation is to be by direct seeding machine (see later) or other means such as grading/ripping, ploughing, or spot cultivation. Eradication of perennial weeds and grasses such as phalaris, cocksfoot, couch, etc. is particularly important. Strips about 1 m wide should be sprayed. The use of residual herbicides is risky, unless a seeding machine can be guaranteed to throw affected soil clear of the sowing furrow on the downhill side.

If applied successfully over broad areas, the cost per tree of direct seeding may be much lower than the cost of planting seedlings. It is also less labour-intensive than planting. The main disadvantage is that the plants germinate under field conditions, so climatic factors may greatly reduce seedling establishment rates and force a second attempt at seeding, thus reducing the economic benefits.

Rates of seed application recommended in furrows are 60 g per 1 kilometre run for larger seed and 150 g per km run for smaller (e.g. eucalypt) seed. For spots and small areas, hand broadcasting seed is suitable. Only about 1% of viable eucalypt seed and 5% of viable Acacia seed is expected to mature into trees. For example, if 600 surviving wattles per ha are required, assuming a 5% survival rate, 12,000 viable seeds should be sown. This equates to 428 grams of wattle seed per ha. It is important to know the viability of various seed lots before sowing so that rates of sowing can be adjusted to supply adequate (but not too much) valuable seed to the furrow or planting bed. A sowing depth of about 2–3 times the diameter of the seed is considered optimal, or about 4–10 mm for eucalypt seed. Seed may need treatment with chemicals to reduce ant theft after sowing. Chemicals such as permethrin, bendiocarb, and boric acid have proven effective in at least protecting grass seeds. The first two chemicals are toxic to fish and should not be allowed to contact water bodies.

In the Lachlan (NSW) area, direct seeding is recommended in the August–September period to take advantage of warming ground and any late winter to spring rain. Autumn sowing is not recommended in areas of inland NSW due to the danger of frost killing young seedlings. If possible, sow when the ground is moist or just before good rain is expected.

Direct seeding machines

Purpose-built direct seeding machines have been developed in recent years, which can give good productivity in suitable conditions (e.g. a machine built by Woodside Landcare, Vic can sow 8 rows x 2 km in one day). Some machines require the site to be herbicide sprayed, while others require the site to be graded. On sloping ground, a continuous furrow should be interrupted at 10-metre intervals



Direct seeding gear in use (courtesy Fin Martin, Greening Australia, Young)

by small check-banks dragged across the furrow with a hoe, rake or shovel, to help pond rainfall and prevent erosion or seed washing downhill. Alternatively, a machine that automatically raises its ripper tine for about one metre in each 10 or 11 m is recommended.

After-care (direct seeded areas)

Emerging plants need to be established before summer. Watering is advisable if the young seedlings are in danger of dying from drought, and thus wasting the investment of seed, operator time and herbicides. It is important to control competing weed growth after planting, with knock-down herbicides, while protecting the new trees or shrubs from the spray. Some thinning of the resulting trees or shrubs will probably be necessary after 3–4 years if germination is good. This will reduce competition and concentrate growth on the more vigorous trees. The aim may be to create a stocking of trees similar to a natural woodland or forest, typically with 100–300 dominant trees per ha, and perhaps a shrub layer underneath. Some patchiness (openings and clumping) in the overstorey species is a more natural structure.

Participating in biodiversity planting projects

Landholders aiming to plant or restore natural vegetation on their property can sometimes gain financial assistance, practical help, and advice by cooperating in a formal project funded by government. There are many such projects at local and regional levels, often aimed at waterway rehabilitation (e.g. Boorowa River Recovery in southern NSW). They are commonly managed or coordinated by bodies such as Greening Australia, Landcare, and Catchment Management Authorities. The Cowra Woodland Birds Program was initiated by Birds Australia and has many cooperating landholders.

Individual landholders should work together with their neighbours to identify key areas on their joint properties that are priorities for maintenance of existing habitat and restoration of biodiversity. Tree and shrub planting is one of the most effective methods of enhancing biodiversity in extensively cleared agricultural landscapes. The beneficial effects of plantings and other wildlife conservation methods will be considerably greater if they are applied over multiple properties and envisaged at the scale of whole catchments.

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