Fauna Issues and Plantation Design Workshop

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Plantation design and fauna conservation in Tasmania

Convenors and editors

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Introduction

Plantations are becoming an increasingly common feature in landscapes throughout Tasmania. Although the State's reserve system goes a long way towards conserving our biodiversity, off-reserve conservation needs to be encouraged at every level and opportunity as many fauna habitats, particularly those of threatened fauna, remain poorly reserved (Draft Framework for Tasmania's Nature Conservation Strategy, March 2000). A 'local level' approach is also required to avoid the negative effects associated with the restriction of species in isolated reserves (Taylor 1991). This requirement for off-reserve conservation includes areas being developed as part of Tasmania's plantation estate, and preliminary guidelines have already been developed for the conservation of biodiversity in areas of State forest being converted to plantation.

A one-day workshop, *Fauna Issues and Plantation Design*, was held at the Cooperative Research Centre for Sustainable Production Forestry in June 2000 in order to review and discuss related work being carried out at Tumut in southern New South Wales and preliminary work here in Tasmania. The aim of the day was to identify the issues and ways to adapt current design and management of plantations for better fauna conservation outcomes. These proceedings contain the abstracts of the talks presented at the meeting and the outcomes of the subsequent discussion.

PART I

A. WORKSHOP ABSTRACTS

The response of arboreal marsupials to context: a large-scale fragmentation study

D.B. Lindenmayer, R.B. Cunningham, M.L. Pope and C.F. Donnelly

An extensive landscape-scale study which examined the effects of fragmentation on populations of arboreal marsupials at Tumut, south-eastern Australia, is described. The region was characterised by a 45 000 ha plantation of exotic *Pinus radiata* trees with 192 patches of remnant eucalypt forest of varying size and shape embedded within it and large continuous areas of eucalypt forest beyond the boundary of the *P. radiata* forest. Our study involved comparing the presence and density of arboreal marsupials in remnants of *Eucalyptus* forest located within the boundaries of the *P. radiata* plantation, in the stands of *P. radiata* forest and in the large areas of continuous *Eucalyptus* forest surrounding the plantation. Sites in continuous *Eucalyptus* forest supported the same forest types and were of similar geological and climatic conditions to those in remnants within the *P. radiata* plantation. The species of arboreal marsupials studied were common brushtail possum (*Trichosurus vulpecula*), mountain brushtail possum (*Trichosurus caninus*), sugar glider (*Petaurus breviceps*), squirrel glider (*Petaurus norfolcensis*), yellow-bellied glider (*Petaurus australis*), feathertail glider (*Acrobates pygmaeus*), common ringtail possum (*Pseudocheirus peregrinus*) and greater glider (*Petauroides volans*). Eighty-six of a possible 192 eucalypt remnants were selected for sampling; these sites varied in size (1–124 ha), shape (long and narrow versus elliptical or round) and other features. Using information on the environmental and climatic conditions, terrain and vegetation cover for the Tumut region, a matched set of 40 sites within large continuous areas of *Eucalyptus* forest and 40 sites in stands of *P. radiata* trees were selected.

Almost no animals were detected in areas of *P. radiata*. Two species, *Petaurus australis* and *P. norfolcensis,* were not recorded in the remnants. *Petaurus norfolcensis* was recorded only once in continuous eucalypt forest and *P. australis* was absent from these areas. Four species, *Petauroides volans, Pseudocheirus peregrinus, Trichosurus vulpecula* and *Trichosurus caninus,* occurred in sufficient numbers for formal statistical analyses of context effects. *Pinus radiata* sites were excluded from these analyses because of the paucity of animals in these areas. There was no effect of site context on the total number of arboreal marsupials. However, *Petauroides volans* was less likely to be found in remnants while *Pseudocheirus peregrinus* was less likely to be found in sites in continuous eucalypt forest. Similarly, site context did not affect the overall density of animals, or the density of *Petauroides volans, Trichosurus vulpecula* and *Trichosurus caninus. Pseudocheirus peregrinus* was more abundant in remnants than in sites in continuous eucalypt forest.

After statistically controlling for environmental, climatic, terrain and vegetation variables, the above results relating to density of animals did not change. The same was found for the presence of *Trichosurus vulpecula* and *Trichosurus caninus.* However, context effects for presence of *Petauroides volans* and *Pseudocheirus peregrinus* could be explained by some of the vegetation and terrain covariates. For arboreal marsupials (any species) and *Trichosurus vulpecula* and *Petauroides volans*, the probability of occurrence significantly increased with area. These results indicated an area of 8 ha for remnants ensures a greater than 80% probability of finding an arboreal marsupial.

Our investigation indicated that areas of remnant eucalypt forest appear to be valuable refugia for some species of arboreal marsupials. Future expansions of *P. radiata* plantations planned for degraded and partially cleared agricultural landscapes in many parts of south-eastern Australia should ensure that existing remnant *Eucalyptus* forests are not cleared.

Effects of forest fragmentation on bird assemblages in a novel landscape context

D.B. Lindenmayer, R.B. Cunningham, C.F. Donnelly, H.A. Nix and B.D. Lindenmayer

We report findings of a large-scale study in a 100 000 ha sub-section of the Tumut region in southern New South Wales in south-eastern Australia. The study was designed to measure the effects of landscape context and habitat fragmentation on forest birds. The study region consisted of a forest mosaic characterised by different landscape contexts. These included large continuous areas of native *Eucalyptus* forest, extensive stands of exotic softwood (*Pinus radiata*) plantation, and remnant patches of native *Eucalyptus* forest scattered throughout the extensive areas of *P. radiata* plantation. A set of 85 eucalypt remnants was randomly selected across several stratifying variables: four patch-size classes (1–3 ha, 4–10 ha, 11–20 ha and > 20 ha), two isolation age classes (< and > 20 years since fragmentation), and five dominant eucalypt forest-type classes. In addition to the 85 eucalypt remnants, a further 80 three-hectare sites were selected for study; 40 in large continuous areas of eucalypt forest and 40 in *P. radiata* stands. Point interval counts of forest birds at the 165 sites were conducted in 1996 and 1997. Of 90 species recorded, an average of 23.1 (95% confidence interval: 22.0 to 24.2) species were present in continuous eucalypt forest; 20.6 (19.5, 21.7) species in patch-shaped eucalypt remnants; 20.6 (19.5, 21.7) species in strip-shaped eucalypt remnants; and 16.7 (15.6, 17.8) species in *P. radiata* plantation. Strong gradients in bird assemblages were found. These gradients were governed by a combination of landscape context, remnant size and remnant shape effects and, in the case of *P. radiata* sites, the extent of native forest surrounding the pine. These gradients could, in part, be explained by bird life-history attributes such as foraging guild and nesting height. For example, birds more often detected in patch-shaped remnants were smaller, produced smaller clutches, were more likely to be migratory and typically had cup nests or burrows.

The results of our study showed that eucalypt fragments of all sizes and shapes have significant conservation value. This is because they contain many native species of birds, some of which are more abundant in fragments than they are in continuous eucalypt forests, and also because they increase native bird populations in nearby non-native pine plantations.

Plantations and fauna management on State forest in Tasmania

P. Wells

Forestry Tasmania manages 1 523 000 ha of State forest land in Tasmania, including 365 000 ha of formal and informal reserves and 1 158 000 ha of wood-production forest. Of the total State forest area, 2.8% is currently managed for hardwood and softwood plantations. Under Forestry Tasmania's Growth Plan, this will grow to 5.1% over the next ten years. Plantations are being established in nodes which include both conversion of native forests and development of already cleared land. Key fauna management issues to be addressed as part of the plantation establishment program include minimising habitat fragmentation and management of threatened species. Forestry Tasmania has adopted a four-tiered approach to strategic planning for fauna management within the developing plantation estate. These include:

- A network of formal and informal reserves across the landscape (part of Tasmania's comprehensive, adequate and representative (CAR) reserve system, which currently includes 40% of Tasmania's forest);
- Planning guidelines for retention of a network of native forest corridors throughout plantation nodes;
- Conservation management plans for individual threatened species most likely to be affected by plantation development; and
- Coupe level assessments as part of the Forest Practices system.

In conjunction with this strategic planning, Forestry Tasmania has a research program specifically targetting plantation biodiversity issues. This program has two levels, one focussing on operational, species-based issues and the other focussing on multiple-species management and landscape-scale assessment. Key projects include investigating the viability and adequacy of wildlife habitat strips within plantation nodes, modelling key threatened species habitat (including population viability analyses, landscape metrics and occupancy modelling), invertebrate and bryophyte field sampling, and investigations of the impacts of forest operations on aquatic habitat (especially in headwater streams).

Landscape design for fauna conservation in intensive-use zones in wood-production forests

R. Taylor

A system for the conservation of biodiversity in wood-production environments can be constructed from the following elements: formal reserves, informal reserves, future use of logged coupes, scheduling of the logging of coupes, the degree of dispersion of logging and prescriptions applied on a coupe. The Tasmanian RFA has determined the formal reserve system for Tasmania relating to forest ecosystems. Various projects are presently examining the value of different prescriptions relating to retention of important elements within coupes when they are logged (e.g. habitat trees, coarse woody debris, structural retention).

As an outcome of the RFA, Forestry Tasmania is increasing its establishment of plantations on State forest. We are undertaking a project that is examining how we can best design landscapes within forest areas where establishment of plantations is to be concentrated. This work involves trying to find optimal solutions using some of the elements that influence biodiversity (i.e. informal reserves, future use of logged coupes, scheduling of the logging of coupes and the degree of dispersion of logging) within the constraints of an increased plantation estate.

The first phase of the project involved examining the snail *Tasmaphena lamproides* in the Togari block in north-western Tasmania. This species is listed as rare on the schedules of the *Threatened Species Protection Act 1995* and the Togari block has been selected as an area where plantation development is to be concentrated. Populations of *T. lamproides* may be eliminated by logging but individuals begin to re-invade around 20 to 30 years after logging. After about 60 years, their populations have reached pre-logging levels. The Murchison Forest District suggested the retention of a chain of native forest coupes running through the middle of the block as a mechanism to aid the conservation of the snail. These coupes would be logged and regenerated but not converted to plantation. In order to compare the impacts of various scenarios on the snail, a spatially explicit population model was developed using the population viability analysis package 'Ramas Metapop'. The model was used to examine the following questions:

- What is the impact of different levels of plantation development?
- What is the value of the biodiversity spine?
- What is the influence of scheduling of coupes?
- What is the effect of dispersed harvesting compared with logging on a front?

The District plan with the retention of a biodiversity spine was compared with a scenario where all coupes were converted to plantation and a scenario where all coupes were regenerated to native forest.

Under all scenarios, there was a rapid decline in the population. However, the risk to the population of reaching unacceptably low levels was greatest for the all-plantation scenario. The all-native forest and the District plan differed only slightly from each other. The scheduling of logging had a major impact on the species; a scenario where logging was evenly spaced over a rotation length produces better outcomes for the species compared with a scenario where all coupes were logged within a short time-frame and then left until the end of the rotation. A longer rotation for the native forest coupes was also better for the species than a shorter rotation. The value of dispersion of logging versus logging on a front varied depending on the level of plantation development. For the District plan with retention of a biodiversity spine, dispersed harvesting was better for the snail population. Retention of the native forest coupes together in a spine was also better for the snail than dispersing the retained native forest coupes evenly through the plantation coupes.

Our studies have confirmed the value of the biodiversity spine and have pointed to the importance of the scheduling of the logging of coupes within the spine. These mechanisms are being used to develop a plan for the conservation of the species over its whole range.

In order to develop guidelines that will cater for the conservation of a large range of biodiversity in intensively managed wood-production environments, we are developing a multiple-species approach using the techniques trialled on *T. lamproides.* It is not possible to repeat the study undertaken on *T. lamproides* on all sensitive species. We have undertaken a review of the literature to see what attributes were associated with species that suffer long-term deleterious impacts from logging. The next step in the project is to select a range of species from different taxonomic groups and habitats that exhibit the ecological attributes found to be associated with sensitivity to intensive wood-production environments. Modelling of these species will then be undertaken to examine their responses to different landscape designs. If the requirements of different species conflict, decision theory will be used to try to achieve an optimum solution for all species.

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Balancing browsing damage management and fauna conservation in plantation forestry

C. McArthur

There is a hierarchy of spatial scales that can affect how much seedlings are damaged by mammalian herbivores in plantation forestry:

1. Seedlings—how palatable they are;
2. Plantation—its size, shape and vegetation;
3. Landscape—the number, size and distribution of plantations and other habitats.

These three levels should affect browsing damage because they affect how much each animal eats from each seedling and how many animals are present. We should therefore be able to use these features to reduce browsing damage. This, in turn, would reduce the reliance on the current lethal methods for reducing damage (i.e. use of '1080' (sodium monofluoroacetate) or shooting of herbivores). However, we need to consider whether any factors that benefit the management of browsing damage complement or conflict with fauna conservation management.

Our data show that several features of plantations and the surrounding landscape affect how severely seedlings are browsed. In a detailed study of one *Eucalyptus nitens* plantation in northern Tasmania, height of seedlings varied enormously 16 months after planting (McArthur *et al.* 2000). Height strongly depended on the size of the region within the plantation in which a seedling was planted and, to a lesser extent, the type of habitat bordering the closest boundary to the seedling. Seedlings in small (2–3 ha) regions of the plantation, for example, were less than half the height of those in a larger region (*c.* 20 ha). These differences in height were mainly due to different levels of browsing by mammals.

A large study of 32 *E. nitens* plantations around Tasmania also showed that features of plantations and the surrounding habitat affected the extent to which seedlings were damaged (Bulinski 1999). Canopy closure of surrounding forest, perimeter to area ratio of the plantation itself and the percentage of the plantation perimeter adjacent to forest all affected browsing damage. The first two characteristics were negatively correlated with damage and the third was positively correlated.

Conclusions from both these studies are that if seedlings are in a small plantation or in a small part of a plantation (i.e. an area with high perimeter to area ratio) and / or if the plantation is surrounded by suitable habitat for herbivores, then the risk of browsing damage is relatively high. Therefore, to reduce browsing damage, we would suggest using large plantations, avoid convoluted edges and, if possible, avoid placing them amongst open forest. However, if plantations are poor habitat for fauna in general and if large plantations fragment the landscape and reduce available habitat for animals, then these recommendations appear to conflict with the broader requirements of fauna conservation.

I suggest that two approaches could help resolve this potential conflict in management requirements. Firstly, we need to confirm what conservation value plantations themselves have for fauna other than herbivores, and determine what features are needed to maximise fauna conservation. If requirements for reducing browsing conflict with those for fauna conservation, then presumably plantation design must concentrate on satisfying the management issue with higher priority. Secondly, we should consider fauna conservation at the scale of the landscape rather than the plantation.

If we aim to maximise fauna conservation values at the landscape level, then plantation design could largely be considered in terms of where they are in the landscape, and particularly *what else* remains in the landscape at any one time. The goal should be to maintain an appropriate mix of plantations and other habitats, by total area and by spatial distribution or patchiness, for conserving fauna. In this way, features of plantations could be designed to suit requirements for reducing browsing damage on plantations while fauna conservation could be achieved at the higher landscape scale.

Use of the forestry environment by herbivores

K. le Mar

Habitat selection was examined amongst five herbivore species in a patchy, commercially forested environment in north-western Tasmania. The five herbivore species included the Tasmanian pademelon, Bennett's wallaby, brushtail possum, European rabbit and common wombat. Nocturnal line-transect surveys showed that pademelons dominated the 430 ha study site, followed by Bennett's wallaby, with the other species present in relatively low densities. Comparisons of species' densities between habitat types showed that pademelons, Bennett's wallabies and wombats used the newly established *Eucalyptus nitens* plantation (with relatively high weed cover) and grasslands significantly more than 5–7-year-old *E. nitens* plantations and native forest (rainforest and wet eucalypt forest). Results were less clear-cut for possums and rabbits, but lowest densities were found in older plantations and native forest. Macropod distribution on the newly established plantation was modelled in relation to nearest distance to landscape features (shelter, feeding grounds and waterways). No pattern was detected for pademelons. This was surprising as pademelons are considered a forest-edge species. Pademelons, however, appeared to use windrows for shelter which would negate their reliance on the coupe edge. The presence of Bennett's wallabies was associated with distance inwards from the plantation edge and, to a minor extent, with proximity to grasslands and waterways.

Implications of this work

Landscape scale.—The implication of this work in relation to forestry production is that by fragmenting the landscape, the environment becomes more attractive to macropods. This is because shelter habitat and feeding grounds exist side by side. It is therefore possible that macropod densities could be reduced at a landscape level by reducing fragmentation. This could be achieved through plantation distribution (clustering plantations) and plantation design (designing large plantations). Reduced macropod densities at a regional scale would, theoretically, be associated with lower seedling damage.

The conservation implication of this work is that decreasing fragmentation may directly conflict with practices required to conserve other native species.

Plantation level.—It appears that pademelons can be distributed throughout a plantation if they can shelter in windrows when they are far from forest edges. Consequently, by removing windrows, pademelon densities on plantations could be reduced, or at least restricted to edge regions. As a result, seedling damage caused by pademelons should also be reduced and restricted to the plantation edge.

However, the conservation implication of removing windrows is that this action may also remove shelter potentially available for native species such as the bettong and wombat. Hence, the conservation value of the plantations themselves may be reduced.

Conclusions

Measures taken to reduce herbivore abundance at both large and small scales may directly conflict with strategies required to conserve other native species. As a result, plantation design will depend on the relative priorities of conservation and production in forestry.

B. DISCUSSION OUTCOMES

The papers presented at this workshop highlighted the complexity of the issue and the difficulty of developing simple rules to balance the requirements for fauna conservation with the requirements of an increased plantation estate. It was recognised that only one element of Tasmania's natural diversity (i.e. fauna) was considered at this workshop and that the development of any prescriptions for the design of the plantation estate needs to take into account other elements such as flora, geo-diversity, freshwater systems, landscape values etc.

The key research results of two studies presented by Lindenmayer provided valuable information on the effect of plantation establishment on mammals and birds. The work highlighted the value to fauna of retained remnant patches and linkages (including riparian zones) of native forest in the plantation matrix both at the local and landscape scale. Some recent work on the occurrence of leaf litter invertebrates in plantations, which also supports the value of retaining remnant patches of native vegetation in the plantation matrix, was raised by a member of the group (K. Bonham, pers. comm.). The long-term viability of such retained areas of native forest in some areas where plantations are being established in Tasmania was raised as a concern. The group recommended that the long-term viability and management of remnants needs to be taken into account when establishing new plantations. The importance of adapting the management of plantations to maintain understorey structure to enhance habitat value was also discussed.

One major concern raised was the conversion of continuous areas of native forest to plantation in Tasmania. Taylor and Wells noted in their papers that, as an outcome of the Regional Forest Agreement, Forestry Tasmania is increasing its establishment of plantations on State forest and that this includes both conversion of native forests and development of already cleared land. The question of whether or not the objectives of both fauna conservation and the increased plantation estate in Tasmania would be best balanced by expanding existing plantations or by having a scatter of new plantations in the native forest landscape was raised. It was recommended that a risk-management assessment should be undertaken to assist with planning the placement of new plantations in a particular landscape, similar to the work carried out for plantation development in the range of *T. lamproides* (Taylor, this workshop). The need for more information on the range and habitat requirements of sensitive species (those likely to be negatively affected by plantation establishment) was emphasised.

McArthur and le Mar highlighted the emerging conflict arising between the design of new plantation coupes to reduce impact from browsers (and hence the need to use 1080) and the design recommendations to maintain fauna diversity at the local level. It was suggested that, in areas where populations of non-target species are low, there may be opportunities for a trade-off between the need to reduce browsing pressure and general fauna conservation. However, the group flagged the need for more work on the distribution of non-target species in the landscape and more work on the long-term impact of 1080 on populations of non-target species.

The talks revealed that there is information available which can be used in the development of general principles and recommendations for the design of plantations to aid fauna conservation in a particular landscape in Tasmania. However, the specific design of the plantation / native forest mosaic in any plantation node (where and how much) is limited by the dearth of information on the distribution and characteristics of habitat utilised by sensitive species in Tasmania. Such information is urgently required to ensure the conservation of such species. Monitoring programs also need to be developed and implemented to test and refine the current guidelines.

PART 2

PRINCIPLES AND RECOMMENDATIONS

D. Lindemayer and S. Munks

These recommendations have been developed from information presented and discussions at the *Fauna Issues and Plantation Design* workshop. They also incorporate existing guidelines produced by the Rural Industries Research and Development Corporation (Short Report 77) and recent work being conducted in Tasmania. (See the bibliography at the end of this paper for the sources of information used.) They outline ways in which plantations may be designed and managed to achieve improved conservation outcomes for fauna in landscapes dominated by new and existing plantations. They have been prepared as a basis for the development of more prescriptive guidelines which will take into account other components of Tasmania's natural diversity to be delivered through the Forest Practices System.

Establishing new plantations and expanding existing plantations in native forest landscapes

PRINCIPLES

- Different groups of fauna respond differently to fragmentation of native forest landscape through the conversion to plantation. Even closely related fauna species may respond differently to fragmentation.

- Landscapes composed of a mosaic of large and small native vegetation patches, strips, riparian strips and plantation stands have significantly higher biodiversity value than a plantation monoculture. Landscape heterogeneity can be important for fauna conservation; remnant native vegetation and plantation trees can interact to provide habitat.

- Native vegetation in gullies and stream areas (riparian zones) can make a significant contribution to biodiversity conservation, even that along small headwater streams and gullies. This vegetation may be particularly important for the dispersal of small native mammals.

- Remnant patches of native vegetation in the plantation matrix are important—even small ones (0.5ha).

- Remnants of small and intermediate size can support many bird species.

- Remnant patches of native vegetation within 500 m of large continuous areas of native vegetation are more likely to be occupied by some vertebrate taxa (small mammals, arboreal marsupials and birds) than are more isolated ones. However, even isolated patches can have significant conservation value for many species (e.g. birds, leaf litter invertebrates).

- The long-term viability of patches and strips of native vegetation retained within a plantation matrix may vary between forest types. Small patches and narrow strips retained in dry forest types converted to plantations are particularly vulnerable to weed invasion.

- Measures recommended to reduce herbivore abundance at both the landscape and coupe scale may directly conflict with strategies required to conserve other fauna species.

RECOMMENDATIONS

Strategic planning

Location

- Avoid conversion of areas of continuous native vegetation containing critical habitat for sensitive species (i.e. threatened species or RFA priority species).

- The fauna values of a particular area should be taken into account when planning the placement of plantation coupes in the landscape (i.e. large plantation nodes versus dispersal of plantation coupes). In some landscapes, it may be best to have a scatter of plantations while in others it may be best to infill and expand existing plantations. In both, the distribution of habitats for sensitive species (including threatened species) should be taken into account. It is important to note that guidelines for plantation establishment and conservation strategies within plantations are in their infancy due to limited available data. Given present uncertainty, it is important to ensure that not all forest landscapes are treated in a uniform manner. Rather, the prescriptions for plantation establishment and vegetation conservation should be varied within and between different forest landscapes. This is a riskspreading strategy that assists forest conservation and management because if one strategy is found to be deficient, then other ones will be in place.

- Where possible, avoid siting softwood plantations directly adjacent to reserves or retained native vegetation dominated by dry forest types.

Habitat retention

- When resources are available, simulation modelling methods (e.g. population viability analysis, landscape metrics) may be useful when planning the design of the forest mosaic within the range of a sensitive species. This may assist the determination of retention of important habitats and the testing of different retention patterns in time and space.

- Large plantations (> 1000 ha) should contain at least 30% remnant native vegetation. A mosaic of remnant native forest patches should be retained. As far as possible, retain a representative range of local vegetation types within retained patches.

- Priority should be given to the retention of patches of remnant native vegetation within 500 m of larger continuous native forest areas to assist fauna conservation.

- Where possible, the plantation establishment schedule should be timed such that, at any one time, native forest remnants are linked by either undisturbed native forest strips (streamside reserves, wildlife habitat strips) or advanced plantation regrowth.

- The long-term viability and management of native vegetation retained within a plantation matrix should be monitored.

Operational planning

Habitat retention

- Native vegetation within riparian zones should be retained within the plantation matrix.

- Green windrowing is preferable during site preparation to aid protection of remnants and other retained areas from fire.

- Radiata pine wildlings should be removed from existing remnants.

Managing browsing damage

- Larger coupes (but not more than 100 ha) with a low perimeter to area ratio are recommended where the impact of browsers on newly established plantations are predicted as being extremely high. This will reduce the need to use undesirable browsing control methods (i.e. 1080 poison).

Plantation management

- The plantation should be managed to encourage regeneration of native understorey vegetation for biodiversity conservation reasons.

Establishing new plantations in semi-cleared landscapes

PRINCIPLES

The principles given above for establishing plantations in a native forest landscape apply equally to the establishment of new plantations in semi-cleared landscapes. In addition:

- Leaf litter invertebrate species and other species (e.g. some birds) can benefit from the establishment of plantations on previously cleared agricultural land.

RECOMMENDATIONS

Strategic planning

Habitat retention

- Remnant patches of native vegetation (even single manferns in gullies) should be retained within the plantation area.

- Remnant patches of native vegetation should not be cleared for plantation establishment, particularly areas of 0.5 ha or larger. Isolated patches of native vegetation should not be cleared simply because they are isolated.

- If plantation establishment results in some native vegetation clearance, then native vegetation should be restored elsewhere in the plantation estate, particularly along gully lines. Restoration of native vegetation linkages between remnants is important. Wildlife habitat strips should be established between remnants where possible, to enhance connectivity between remnants.

- Large plantations (> 1000 ha) should contain at least 30% as remnant native vegetation. Restoration efforts may be needed to achieve this level of native forest cover within the plantation estate.

Operational planning

Habitat retention

- Riparian zones (streamside reserves) as prescribed in the *Forest Practices Code* should be retained and restored.

- Where remnant native forest is retained, efforts are required to protect these areas from hot burns during site preparation.

- Firewood collection and stock grazing should be excluded from any retained native vegetation.

Plantation management

- Plantations should be managed to encourage native understorey species regeneration.

- Plantation establishment processes that encourage habitats (rotting logs) and accelerated litter production, enabling rapid re-invasion by leaf litter invertebrates should be used; that is, furrowing, windrowing, and retention of logs and stumps after thinning.

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