Department of Sustainability and Environment

Action Statement

Flora and Fauna Guarantee Act 1988 No. 192

Loss of hollow-bearing trees from Victorian native forests and woodlands

Description and occurrence

Hollows that form in trees provide essential breeding and roosting spaces for many native wildlife species. Native Australian trees do not usually develop hollows suitable for use by vertebrates until they are very old. Large hollows, essential for some fauna, do not develop until trees are well over a hundred years old; the development of large hollows being a characteristic feature of tree senescence (Jacobs 1955; Ambrose 1979; Mackowski 1984; Perry *et al.* 1985; Inions *et al.* 1989). Hollows develop in Australian trees largely as a result of natural branch shedding and damage by wind, lightning, fungi and wood-boring insects, particularly termites. Fire can accelerate this damage, but it also accelerates deterioration and collapse of existing hollow trees. In contrast to other parts of the world, where animals like woodpeckers actively excavate holes, the only primary hole-excavating vertebrate animals in Australia are a few species of tropical parrot.

Some eucalypt species (eg River Red Gum *Eucalyptus camaldulensis*) may survive for many centuries, providing a dynamic supply of hollows that suit different species at different stages of hollow development. Each animal species has its own requirements and preferences for factors such as hollow size, location (branch or trunk), tree species and surrounding vegetation. Old trees may continue to provide hollows for many years between death and eventual collapse and decay.

Hollow-bearing trees are usually the oldest and largest members of their communities. Therefore they often have values beyond the hollows they contain that cannot be provided by younger trees; by virtue of their age, size, form, root development and ability to sequester resources from surrounding vegetation. These include: landscape value; a large and diverse invertebrate fauna, particularly in peeling bark which provides a distinctive foraging substrate; non-hollow nest, roost and perch sites; nest materials; open stand structure; clusters of mistletoes and other epiphytes, and a more regular and prolific flowering and nectar production (Ashton 1975; Recher *et al.* 1980; Loyn 1980; Smith & Woodgate 1985; Lunney *et al.* 1985, 1988; Kavanagh 1987; Taylor & Savva 1988; Lindenmayer *et al.* 1991a, 1991c; Recher 1991; Scotts 1991; Morrison 1992; Webster & Menkhorst 1992).

When large trees eventually collapse or fall, they provide a range of resources for different groups of fauna. Large hollow logs on the forest floor are used by ground-dwelling animals, particularly mammals, for shelter and as foraging sites (eg How 1983; Dickman 1991; Scotts 1991). Branches and trees falling into water provide shelter for fish and other aquatic animals (Koehn & O'Connor 1990; Benke *et al.* 1984). Rotting wood contributes nutrients and organic matter to the soil, and fungi are used as food by various mammals including possums, bandicoots and potoroos.

Rates of formation and loss of hollow-bearing trees have been affected by European settlement in all Australian states. Usually this has involved accelerated rates of loss (principally through clearing for agriculture) and reduced rates of formation (by preventing regeneration of trees in farmland, or as a consequence of wildfire (eg 1939 fires) or timber harvesting activities in areas of forests); hence numbers of hollow-bearing trees are reduced.

Ecological role of hollows

Hollows are considered essential for 16 species of mammal and 44 species of bird in Victoria (Emison *et al.* 1987; Menkhorst 1984b, *pers. comm.*; Appendix 1), including 14 mammals and birds considered threatened in Victoria (NRE 2000). The Tree Goanna *Varanus varius* is also dependent upon hollows for shelter (Scotts 1991)

Hollows are also used opportunistically by at least 17 species of mammal, (2 of which are threatened) (NRE 2000), 17 species of bird (Ambrose 1979; Emison *et al.* 1987; Menkhorst 1984b, *pers comm.* Appendix 1), and the threatened snakes Diamond Python *Morelia spilota spilota* and Carpet Python *Morelia spilota variegata*. However, the loss of hollow-bearing trees may not be the main factor affecting the conservation status of these species because they can use alternative sites.

For fauna that use hollows, the hollows are usually only important for shelter, roosting or nesting. Foraging occurs in surrounding habitat that does not necessarily need to contain hollow-bearing trees. For instance, while bats need large trees for roosting, some species will feed in younger forest at least 12 km from their roost sites (Taylor & Savva 1988; Cherry *et al.* 1992). Similarly, while the prey of Sooty Owls *Tyto tenebricosa* in extensive mature forests is largely hollow-dependent (Milledge & Palmer 1990), the owls will feed on a wider range of prey where suitable roosting and nesting habitat is only available in gullies within open or younger forest (Smith 1984; Loyn *et al.* 1986). The relative long-term success of populations in which the distribution of hollow-bearing trees is patchy is not yet known.

Another ecological issue is that some species need several hollows in close proximity, to support a social community, to provide a choice of hollows for different circumstances, to allow regular movements for hygienic reasons, or to avoid ectoparasites (eg with Brown Antechinus *Antechinus agilis*; Cockburn & Lazenby-Cohen 1992). Each species has its own requirements for type of hollow, and various habitat and social needs determine the density of hollows that may be most useful to that species.

There are several studies that suggest a shortage of hollows is limiting the abundance of some fauna species. In the Wombat State Forest, some species increased in abundance when artificial hollows were provided (Calder *et al.* 1979). Artificial hollows are more likely to be used in forests where hollows are scarce than where they are plentiful (Golding 1979; Menkhorst 1984a). In montane ash, River Red Gum and box-ironbark forests, strong correlations have been found between abundance of arboreal mammals and densities of old hollow-bearing trees (Smith & Lindenmayer 1988; Lindenmayer *et al.* 1991a,b; A. Bennett, Deakin University pers. comm.).

Status of threat

The 'Loss of hollow bearing trees from Victorian native forests' is listed as a Potentially Threatening Process under the **Flora and Fauna Guarantee Act 1988**. The 'Continuing net loss of hollow-bearing trees in native forests and woodlands due to firewood harvesting practices' has been nominated and recommended for listing as a Key Threatening Process under the Commonwealth **Environment Protection and Biodiversity Conservation Act 1999.**

Factors influencing the loss of hollow-bearing trees

Permanent clearing on private land or along roads

Permanent loss of hollow-bearing trees occurs primarily as a result of clearing for agriculture and urban development. Most of the losses from this cause have already occurred in Victoria but remnant trees are still being felled for firewood. This permanent loss has occurred and is continuing to occur primarily on private land in the grassy woodlands of northern and western Victoria and in Gippsland Burbidge 1985; Joseph *et al.* 1991). Changes to farming practices may lead to a loss of scattered trees on farms, including live or dead hollow-bearing trees. In the past decade there has been a substantial move from grazing to cropping in parts of Victoria, and towards large-scale irrigation systems, which can also lead to the removal of isolated trees.

These trees may represent important remnants of native forest. In addition, when hollow-bearing trees die from old age, exposure to windfall or as a result of land degradation, they are not being replaced through regeneration because of grazing by stock, rabbits and kangaroos.

Dead trees, which often contain hollows important to wildlife, are generally not protected under the current Native Vegetation Retention controls. Retention of hollow-bearing trees and encouragement of regeneration may be assisted by provision of financial incentives to forego the cutting of trees for firewood or fence posts, and to fence areas (using metal posts, in some cases) to encourage natural regeneration and to protect seedlings. Supply of artificial hollows may be necessary for endangered fauna, such as the Red-tailed Black-Cockatoo (Joseph *et al.* 1991), as an interim measure until natural hollows can be restored.

Large trees, many of which are likely to contain hollows, are commonly considered an essential feature of the rural Victorian landscape. The progressive loss of these trees in western Victoria may affect overall attitudes to the land, land values and the attractiveness of the region to tourists. Loss of these trees can have serious effects on erosion, water tables and soil salination. They provide a valuable source of shade and shelter for stock. Protection of trees involves outlays for fencing and other protective measures. It may involve some temporary cost in terms of stock numbers, and a reduction in firewood supply to sustainable levels.

Deliberate permanent removal of hollow-bearing trees from public land on a large scale has ceased but small, possibly significant, areas continue to be cleared through activities such as road construction. Roadside trees are a particularly important source of hollows in rural landscapes. Extensive tree planting schemes have been undertaken along new roads, and old trees have often been protected as well. However, there has also been a tendency to remove old trees when they are assessed as a hazard to traffic or a fire risk in relation to power lines. The management issue is to ensure the right balance, and in particular to avoid unnecessary removal of old hollow-bearing trees that may take centuries to replace.

Forest harvesting

Forest management practices that result in a net loss of hollow-bearing trees include timber harvesting, some silvicultural practices and fuel reduction burning. Relative to an undisturbed forest, the number of new hollows formed will be reduced on non-selectively harvested areas (ie clearfall and seedtree systems) because fewer trees grow on and replace old trees as they proceed through various stages of decay and eventual collapse. However, the rate of hollow development may increase as a result of incidental damage to retained trees during harvesting operations. Another consideration is that the survival of retained trees in and beside coupes may be reduced after harvesting through increased exposure and effects of fire used for regeneration. High intensity regeneration burns to promote ash germination can result in premature death of retained trees. However, less intensive regeneration burning in mixed species forests may enhance hollow development. In contrast, in an old forest, the major agents of tree death are fire, fungi and insects, whose effects may interact and increase with old age. These impacts are generally reduced in less intensive, selective harvesting systems such as those applied in mixed species and box ironbark forests where regeneration burning is less likely to take place.

Options available to forest managers to retain hollow densities include varying rotation periods, varying silvicultural systems, retaining areas of high hollow density, retaining existing hollow-bearing trees and trees likely to develop hollows in the future within areas available for harvesting.

Less than a quarter of the total area of State forest across Victoria is available or suitable for timber harvesting. In addition to maintaining a representative reserve system, it is crucial to manage non-reserved areas to ensure that sufficient habitat elements are protected and maintained into the future. Key mechanisms for conserving habitat features including hollow-bearing trees within State forest are:

- exclusion or modification of timber harvesting and other disturbances through the application of forest management zones, and/or
- application of prescriptions (rules) governing the way in which these activities are carried out to minimise impacts on habitat values. Forest management zones and prescriptions for the retention of wildlife habitat in State forests are specified in Forest Management Plans and Regional Forest Management Prescriptions, in accordance with the 'Code of Forest Practices for Timber Production' (CFPTP-NRE 1996). Prescriptions vary according to region and forest type.

In relation to hollow-dependent species, the critical factors to consider when developing prescriptions include:

- the habitat requirements of fauna species and their prey, including minimum number, size and type, location of hollow, preferred species and location within the landscape;
- the distribution of hollow-bearing trees taking into account dispersal distances of fauna species;
- the growth stages of the forest to plan for adequate recruitment of hollow-bearing trees over time;
- the forest in the context of the surrounding landscape and existing habitat;
- silvicultural considerations, including adequate regeneration response, and
- operational considerations, including occupational health and safety.

Fire

Severe wildfires can reduce numbers of hollows by killing most of a particular cohort of trees, resulting in a relatively even-aged regrowth with a few old or dead trees. This may create a

temporary abundance of hollows as large, fire-killed trees decay, but over the following decades these trees are likely to collapse more quickly than new hollows are formed. This is currently happening in the Central Highlands, where most trees in 65% of the montane ash forests were killed by wildfire in 1939 (Noble 1977; Smith & Woodgate 1985). The subsequent loss of dead hollow-bearing trees in these forests has been estimated at 3.6% per year, as measured over a five year period in the 1980s (Lindenmayer *et al.* 1990a). Most remaining stags with hollows will collapse in the next 75 years, leaving a period of at least 50 years when there will be a shortage of hollows for Leadbeater's Possum and other arboreal marsupials (Smith and Lindenmayer 1988; Lindenmayer *et al.* 1990a). The problem exists because trees that germinated after the 1939 fires are not yet old enough to develop hollows.

Fuel reduction burns are fires of low intensity used to remove the fine, more flammable fuel from strategic areas within forests and parks. Variables such as the frequency and intensity of prescribed fire and the forest type may also contribute to the rate of hollow development in trees, and the number and survival of trees with hollows. Ecological burning to achieve biodiversity conservation outcomes may also be a useful tool to alter habitat structure and manage for the loss of hollow-bearing trees.

Fire also causes a net loss of hollow-bearing trees in mallee woodlands, where the low canopy may be sensitive to wildfire. Although hollow loss may be accelerated when trees are killed or hollow limbs ignite, burn out and collapse, formation of new hollows may be accelerated by this damage, through subsequent loss of branches and entry of termites and fungal pathogens (Inions *et al.* 1989). In southern New South Wales, eleven species of hole-using mammals are thought to be advantaged by a regime of infrequent intense fires and one species disadvantaged (Catling 1991).

Hollows can also form in tree stumps and even fence posts through decay or fire, and these may be used by some species including Squirrel Gliders *Petaurus norfolcensis* (Traill 1991) and Turquoise Parrots (Quinn & Baker-Gabb 1993), especially where tree hollows are in short supply. However, in the case of Turquoise Parrots, predation of nesting female birds was suspected to be substantial because of their use of these hollows close to the ground (Quinn & Baker-Gabb 1993).

Other management options

Artificial Hollows

There is potential to overcome a scarcity of natural hollows through the provision of artificial hollows and the acceleration of natural hollow development, although the usefulness of artificial hollows, such as next boxes, varies considerably. For instance, the provision of artificial nesting boxes, along with close management of existing natural nesting hollows, is a major component of the recovery program for the endangered Kangaroo Island Glossy Black-Cockatoo (Garnett *el al.* 2000). Artificial nest boxes were also provided for Red-tailed Black-Cockatoo in south-western Victoria, but with minimal success so far. Turquoise Parrots were reluctant to use nest-boxes but used hollow logs strapped to trees (Quinn & Baker-Gabb 1993). In the Whipstick Forest near Bendigo, Brush-tailed Phascogales *Phascogale tapoatafa* used at least one box in each clump of boxes provided (T. Soderquist *pers. comm.*). The provision of nest boxes was instrumental in the successful reintroduction of Sugar Gliders to Tower Hill (Suckling & Macfarlane 1983).

Accelerating hollow-development

The rate of natural hollow formation could be artificially accelerated, such as through removal of tree-tops using explosives, inoculation of trees with fungi (Lindenmayer *et al.* 1991d) or chemicals, artificial establishment of termites, thinning, burning, killing selected trees and direct drilling. A shortage of hollows in regrowth forests resulting from wildfire or past utilisation may be addressed through ecological thinning to promote growth and branch development. It may also be possible to accelerate hollow formation through choice of trees to be used in regeneration or replanting schemes. However, the broad practical application of this process has yet to be demonstrated, and it is likely that, at least initially, it could be applied only in limited specialised circumstances, such as for conserving a highly endangered species. In National Parks and some other reserves, many other factors (eg fire, feral bees) may require management to ensure a continuing supply of available hollow trees.

Existing management measures

- Regulations have been introduced to control and reduce the extent of clearing on public and private land. The Glenelg and West Wimmera Shires have included an Environmental Significance Overlay to protect Red-tailed Black Cockatoo habitat in their local planning schemes Both State and Local Government agencies are involved in the administration of these regulations.
- Many private initiatives by individuals and groups have been taken to maintain existing hollow-bearing trees and to provide artificial hollows. The Bird Observers Club of Australia (BOCA), Bendigo Field Naturalists Club and

Healesville Sanctuary have each produced leaflets on hollows and nest-boxes, with BOCA having a wide range of artificial nest boxes for sale to the public. Healesville Sanctuary conducts an education program including this issue for students. The Victorian Field and Game Association has a number of active programs supplying nest-boxes for waterfowl and encourages its members to undertake individual initiatives.

- The Code of Forest Practice for Timber Production 1996 (Code) requires that planning and harvesting operations in native forests specifically address the conservation and protection of flora and fauna values including the protection and provision for recruitment of old trees and strategies for maintaining a mosaic of corridors and zones to enhance conservation values and biodiversity.
- A comprehensive forest management planning framework, which includes Regional Forest Agreements, Forest Management Plans and associated comprehensive adequate and representative reserve systems, and forest management prescriptions, provides for ecologically sustainable management of Victoria's forest resources.
- Forest management prescriptions provide detailed measures for maintenance and protection of State forest habitat values and indicate how they are to be implemented and how they should be varied for particular forest locations.
- In 2001, the State Forest Flora and Fauna Habitat Management Working Group, recommended a series of objectives and principles for a statewide review of prescriptions for the retention of wildlife habitat, including hollow-bearing trees, within the General Management Zone of Victoria's State forests The recommendations of the Working Group provide for a landscape approach, taking into account harvesting methods, the requirements of key sensitive species and the extent of harvesting within forest landscapes. These principles and objectives will underpin the review of prescriptions for habitat retention across the state.
- Prescriptions for retention of habitat based on the Working Group recommendations are applied in the Wombat State Forest to protect existing and future hollow-bearing trees in harvested areas.
- Detailed prescriptions have been developed and implemented for Leadbeater's Possum in montane ash forests (Macfarlane *et al.* 1995). Under these prescriptions live stands of montane ash forest >120 years old are excluded from logging as well as regrowth ash with >12 hollow-bearing trees/3ha. Veteran old trees are retained on coupes and measures taken to protect them. Trees are also retained to provide hollows in the future, though the optimal pattern and size of retained stands is not yet known and requires further research. Refer to Action Statement
- Research has been conducted on various aspects of hollow-bearing trees for at least 19 wildlife species (Appendix 2).
- Data have already been collected about the incidence of hollows and ground debris from over 3000 State Forest Resource Inventory field plots in State forest throughout Victoria
- Artificial hollows have been erected in numerous forests, often with high occupancy rates (eg Menkhorst 1984a, 1994b; Traill & Lill 1998), including by reintroduced Sugar Gliders (Suckling & Macfarlane 1983) and Brush-tailed Phascogales (T. Soderquist *pers. comm.*).
- Extension work has begun in farmland to encourage the exclusion of stock to allow regeneration, planting of native vegetation and retention of existing vegetation (Landcare, Greening Australia, Potter Farmland Plan, Land for Wildlife). The *Land for Wildlife* scheme has encouraged retention of hollow-bearing trees and management of retained wildlife habitats by its members on nearly 4,000 properties. Regular newsletters, a technical note (Note No. 20), newspaper articles and field days have addressed this issue for a wider audience.

Major Conservation Objectives

Long term objective

To ensure that the conservation status of Victorian fauna is not compromised by a shortage of hollow-bearing trees.

Objectives of this Action Statement

- Significantly reduce the loss of hollow-bearing trees from private land and encourage their retention and replacement.
- Manage parks and State forest to ensure that an appropriate level of hollow-bearing trees is restored and maintained in all forest types.
- Foster an appreciation of the role and importance of hollow-bearing trees in Australian ecosystems.

Intended management actions

The intended management actions listed below are further elaborated in DSE's Actions for Biodiversity Conservation Database. Detailed information about the actions and locations, including priorities, is

held in this system and will be provided annually to land managers and other authorities.

Private land and roadsides

1. Identify, assess and map significant areas or stands of hollow-bearing trees on private land and on roadsides.

   Responsibility: DSE Regions, Catchment Management Authorities, local government authorities, Vicroads

2. Incorporate information on the location and significance of hollow-bearing trees into local government planning mechanisms such as the Vegetation Protection and Environmental Significance Overlays. Develop and apply appropriate planning controls to achieve protection of all significant stands or trees.

   Responsibility: local government authorities

3. Protect hollow-bearing trees and stags on existing roadsides and new alignments, where it is safe to do so. Assess and map stands or isolated trees and incorporate this information early in the planning and execution of road construction and maintenance works.

   Responsibility: local government authorities, Vicroads

4. Incorporate information on the location and significance of hollow-bearing trees into Regional Catchment Strategies and Regional Implementation Plans, via Biodiversity Action Plans. Target activity and investment towards the protection of significant areas or stands of hollow-bearing trees.

   Responsibility: Catchment Management Authorities

5. Provide information and advice to assist local government authorities, Catchment Management Authorities, developers and landholders to protect hollow-bearing trees.

   Responsibility: DSE Regions

6. Continue to encourage and assist private landholders to protect hollow-bearing trees and stags via voluntary programs such as Land For Wildlife, BushTender and Trust for Nature covenants.

   Responsibility: DSE Regions, Trust for Nature

State forest

7. Continue to identify significant areas or stands of hollow-bearing trees in State forest, using the State Forest Resource Inventory and other relevant information, to inform management decisions.

   Responsibility: DSE Parks and Forests Division, DSE Regions

8. Continue to implement a range of measures to maintain or enhance the extent and/or density of hollows in State forest where this is known to be limiting the distribution and/or abundance of hollow-dependent species. These measures include:

- Application of management guidelines, including forest management zones and prescriptions, for fauna species as provided in Forest Management Plans (e.g. Leadbeaters Possum Special Protection Zones and prescriptions).
- The development and application of revised habitat retention prescriptions for areas within the General Management Zone (GMZ) in accordance with the principles and objectives established by the State Forest Flora and Fauna Habitat Management Working Group.

   Responsibility: DSE Forests Service, DSE Regions

Parks and reserves

9. Identify, assess and map significant areas or stands of hollow-bearing trees on parks and reserves, targetting priority species and areas as required.

   Responsibility: Parks Victoria

10. Incorporate measures to maintain or enhance the extent and / or density of hollows in park and reserve management plans where this is considered to be limiting the distribution and / or abundance of hollow-dependent species.

    Responsibility: Parks Victoria

Research and Monitoring

11. Continue to conduct research, including investigation into the formation of hollows and measures to enhance this process, the use of hollows by hollow-dependent species and the effect of hollow distribution and characteristics on population size and reproductive success in such species.

    Responsibility: DSE (Biodiversity and Natural Resources Division)

12. Continue work investigating the use of forest inventory mapping of hollow-bearing trees for developing predictive models of hollow incidence to facilitate appropriate forest management. Initial work has been undertaken (Fox *et al.* 2001).

13. Develop cost effective methods for monitoring the effectiveness of habitat retention measures on a landscape scale.

    Responsibility: DSE (Parks and Forests Service, Biodiversity and Natural Resources)

14. Use the native vegetation permit tracking system to monitor the loss of hollow-bearing trees on private land.

Responsibility: *DSE (Regions)*

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Flora and Fauna Guarantee Action Statements are available from the Department of Sustainability and Environment website: http://www.dse.vic.gov.au

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