Best practice guidelines

for Blue Gum High Forest

National Parks & Wildlife Service NSW

CMA Sydney Metropolitan Catchment Management Authority

Australian Government

Ku-ring-gai Council

Department of **Environment & Climate Change** NSW

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1 Introduction

As Sydney has developed, much of the original vegetation has been cleared or significantly disturbed. Consequently many native plants and animals have become locally extinct or are represented by such small isolated populations that they are threatened with extinction. Remnant natural areas and threatened species require careful management.

Dalrymple–Hay Nature Reserve and Browns Forest at St Ives is one of 11 demonstration sites where best practice methods are being implemented to conserve priority threatened species, populations and communities. This site contains the critically endangered ecological community of blue gum high forest.

The Sydney Metropolitan Catchment Management Authority and Department of Environment and Climate Change NSW (DECC) have provided these guidelines to assist land managers and private land owners to conserve and manage the recovery of blue gum high forest in other locations.

It is important that all restoration projects for blue gum high forest are managed to current best practice standards, as inappropriate restoration can significantly affect the long-term viability of blue gum high forest.

1.1 About blue gum high forest

Blue gum high forest is a moist, tall open forest community with a canopy that can reach over 30 m in height (Figure 1). It only occurs on the relatively fertile soils derived from Wianamatta shale where rainfall is above 1100 mm per year. Its dominant canopy trees are Sydney blue gum (*Eucalyptus saligna*) and blackbutt (*E. pilularis*). Other trees include forest oak (*Allocasuarina torulosa*), grey ironbark (*E. paniculata*) and Sydney red gum (*Angophora costata*). Understorey plants include prickly beard heath (*Leucopogon juniperinus*), narrow-leaved geebung (*Persoonia linearis*) and hop bush (*Dodonaea triquetra*). In moist gullies, rainforest species such as cheese tree (*Glochidion ferdinandi*) and lilly pilly (*Acmena smithii*) are common. Ferns, such as gristle fern (*Blechnum cartilagineum*), soft bracken (*Calochleana dubia*) and maiden hair (*Adiantum aethiopicum*) dominate the understorey (DEC 2005a).

Photo: A. Kwok

Figure 1: Blue gum high forest

1.2 History and distribution

Prior to European settlement blue gum high forest occurred on the shale ridges of northern Sydney, from Crows Nest to Hornsby and west to Baulkham Hills (National Parks Association 2006). From 1805 the tall straight trees of blue gum high forest attracted timber getters, with the timber described by botanists as being very suitable material for building Sydney Town (Benson and Howell 1995).

Timber removal continued into the 1870s, though after the tallest trees had been taken blue gum high forest provided the residents of colonial Sydney with firewood for many years (Benson and Howell 1995). Following clearing, orchards were established on the fertile shale soils from as early as 1826, and after the railways were constructed suburbs developed in most of the remaining area where blue gum high forest once lived (National Parks Association 2006; Benson and Howell 1995).

1.3 Current status and threats

Today blue gum high forest is among the most threatened ecological communities in Australia. With less than 4.5% of its pre-1788 distribution remaining, and less than 1% in conservation reserves, it has been listed as a critically endangered ecological community under both the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) and the *Threatened Species Conservation Act 1995* (NSW).

The remaining remnants of blue gum high forest are located in the local government areas of Ku-ring-gai, Ryde, Hornsby, Parramatta and Baulkham Hills (Figure 2). They persist in council reserves, large backyards, creek lines, schoolyards and along roadsides. These remnants continue to be threatened by processes including (DEC 2005a):

- further clearing for urban development and the subsequent impacts from fragmentation
- mowing, which prevents regeneration
- urban stormwater runoff, which leads to increased nutrients and sedimentation
- weed invasion, as invasive species outcompete native plants for soil nutrients and sunlight and prevent native seeds from germinating
- inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

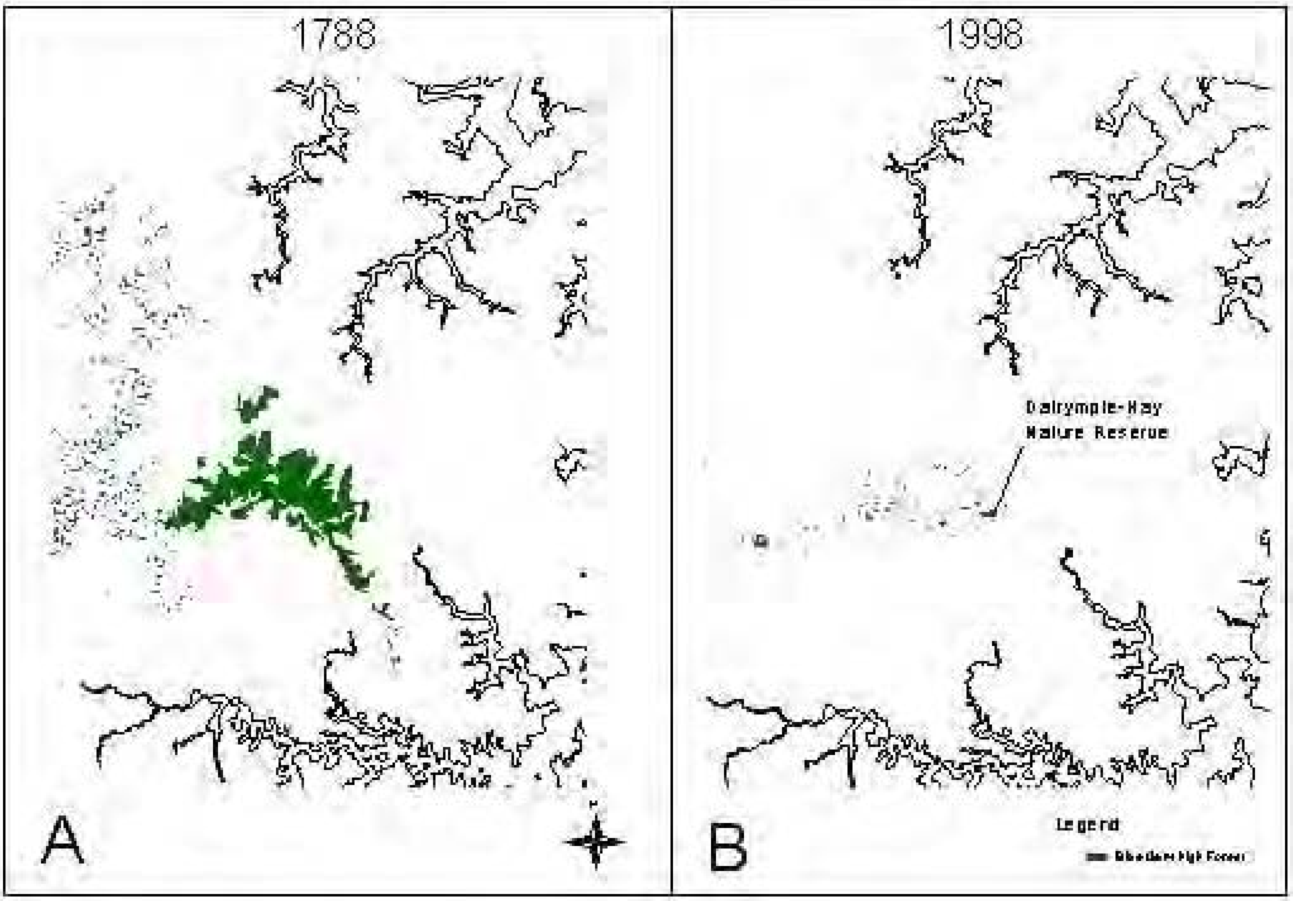


Figure 2: Past and present distribution

2 Dalrymple–Hay Nature Reserve and Browns Forest demonstration site

The largest remnant of blue gum high forest is at St Ives and is found on adjoining properties owned and managed by three agencies: Dalrymple–Hay Nature Reserve and 100 Rosedale Road (DECC), Browns Forest and 102 Rosedale Road (Ku-ring-gai Council) and Sydney Water Reservoir (Sydney Water) (Figure 3).

The St Ives blue gum high forest remnant has never been grazed by domestic animals, and only the largest trees were selectively logged (Blue Gum High Forest Group 2007). Thus, some parts of this forest still retain the structural integrity of the vegetation that existed pre-1788.

2.1 The condition of the reserve before treatment

Before restoration work commenced in 1983, the St Ives blue gum high forest was highly degraded. Bush regenerators from Ku-ring-gai Council, the Blue Gum High Forest Group volunteers and Lane Cove National Park rangers were confronted with a disappearing canopy and weeds which dominated entire sections of the forest. The most abundant introduced plants were lantana (*Lantana camara*), large-leaved privet (*Ligustrum lucidum*), small-leaved privet (*L. sinense*), Madeira vine (*Anredera cordifolia*), camphor laurel (*Cinnamomum camphora*) and the ground covers fishbone fern (*Nephrolepis cordifolia*) and trad (also known as wandering jew) (*Tradescantia fluminensis*). These weeds smother the emergent native species, thereby threatening successive generations of native plants and the survival of this endangered ecological community (Figure 4).

Image: Ku-ring-gai Council (2007)

Figure 3: Aerial photo of the blue gum high forest at St Ives

Without bush regeneration, weeds would eventually grow to dominate the forest. As the weeds dominate the understorey and mid-storey and prevent the germination of seeds, the Sydney blue gum and blackbutt trees which form the canopy that help to define this forest will not be replaced when they die over the next 100–200 years.

Photo: A. Kwok

Figure 4: Lantana and blackberry dominating the mid-storey

2.2 The seedbank

Many blue gum high forest plants can survive for decades as seeds stored in the soil – the seedbank. Even if the forest appears weedy and degraded, it may still contain seeds that can regrow.

The seedbank is the key to regeneration. The appropriate use of fire and removal of weeds can initiate seed germination and help the forest to recover. When the seedbank has gone and the forest cannot regenerate, planting helps recover some of what was lost. Plants grown from seeds collected in blue gum high forest can be used, if the land is available, to create corridors to relink isolated forest remnants or replace the understorey in patches where only the canopy trees remain.

Mulching a blue gum high forest bush regeneration site will prevent seeds from germinating.

3 Guidelines for bushland managers and regenerators

Successful best practice methods implemented in blue gum high forest at St Ives are outlined as follows.

Fire management: Prescribed burns are used for weed control and native flora regeneration. In particular, fire creates a disturbance that is necessary for regeneration of blue gum high forest canopy and mid-storey trees.

Weed management: Removing weeds by hand encourages native flora regeneration. It creates a soil disturbance that tends to favour ground cover and understorey regeneration.

Fauna management: The reserve is home to a variety of native fauna, and management must take into account their habitat needs and cause as little disturbance as possible.

Stormwater control: A pollutant trap to filter stormwater and sandstone boulders to minimise creek bed erosion from flows off Mona Vale Road have been installed.

Access management and community awareness: Non-essential walking tracks have been closed and the importance of regeneration has been promoted to residents neighbouring the reserve.

Monitoring: Ongoing monitoring at previously worked areas, which includes documenting the response of native and weed species after applying a particular bushland regeneration technique, provides feedback on the effectiveness of management strategies.

These practices continue to ensure the survival of this historic remnant, for the benefit of the rich flora and fauna assemblage that defines blue gum high forest and for the local community. A section 132c licence under the *National Parks and Wildlife Act 1974* must be obtained before undertaking regeneration works in blue gum high forest.

3.1 Fire management

In the past, intentional disturbance to an ecosystem has been perceived negatively, as damage and destruction. However, it is now understood that disturbance is a natural process, integral to plant community and ecosystem dynamics (Buchanan 1989; Thomas 1994; McDonald et al. 2002).

With some of Sydney's most established North Shore suburbs now surrounding the blue gum high forest at St Ives, bushfires have become rare. To maintain the ecological health of the forest, a series of prescribed burns has been used to trigger native plant regeneration.

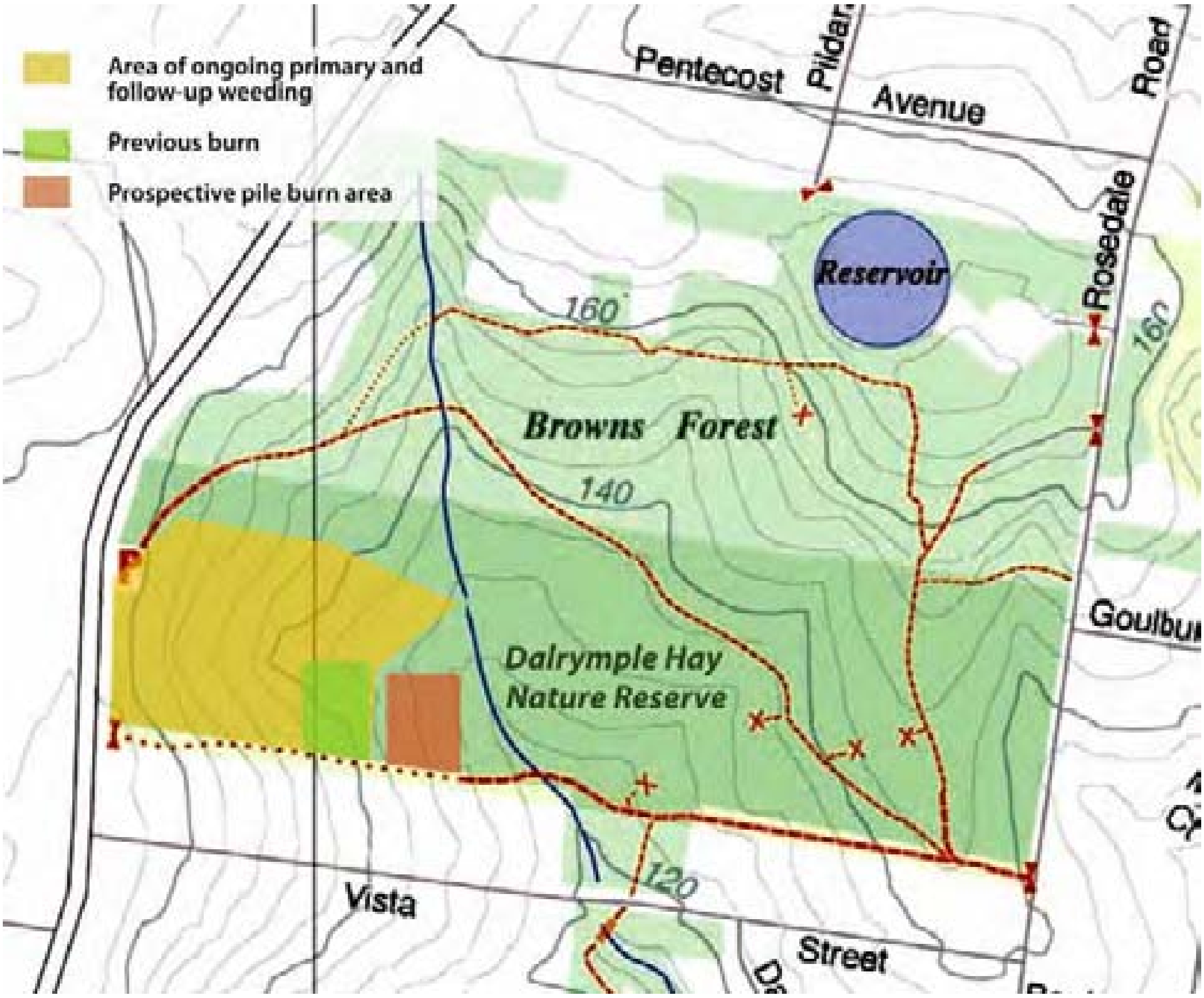
Benefits of fire

Fire creates conditions favourable for seed germination by (Buchanan 1989):

- increasing the amount of sunlight reaching the soil
- benefiting those native plant species which require fire as part of their life cycle
- encouraging new growth of microbial flora and fungi which aid germination
- releasing nutrients (nitrogen and phosphorus) into the soil.

The consequences of *not* implementing prescribed burns are:

- no recruitment – if there is no fire, when the canopy trees die of old age there will be no regenerated young trees to replace them (Buchanan 1989)
- structural changes – low fire frequency substantially increases the presence of exotic plant species such as privet, lantana, camphor laurel and fishbone fern
- reduced seedbank – those native species which require fire to germinate will diminish over time, reducing the capacity of blue gum high forest to respond to future disturbances (McDonald et al. 2002).



Source: BARRC (2007)

Figure 5: Areas zoned for burns

Inappropriate fire regimes

Inappropriate fire regimes have altered the floristic and structural diversity of blue gum high forest (DEC 2005a). Some examples include:

- burning too frequently, which can result in the loss of many native species; the desired fire interval for St Ives blue gum high forest remnant is no fire more than once every 15 years (NPWS 2004; RFS 2004)
- burning an area too large to be maintained by essential follow-up bush regeneration
- not ensuring enough adequate habitat is left for fauna
- allowing the fire to reach the canopy, as crown fires have the potential to kill mature canopy trees; these trees have hollows which are important fauna habitat, and large hollows generally take over 100 years to form
- failing to burn the area to an ash-bed allowing weeds from the unburnt areas to proliferate.

Pre-fire checklist

Before initiating a prescribed burn, ensure that the following are carried out:

- Undertake a fauna search prior to the burn; the fire plan may need to be modified to accommodate species requirements.

- Notify neighbours of the intention to burn.
- Obtain relevant authorisations or permits.
- Arrange adequate fire control measures, such as a tanker, crew and traffic control.
- Prepare and schedule a monitoring and maintenance plan to be implemented after the burn.

A prescribed burn should only be carried out when fire weather conditions are suitable.

The mosaic approach

To avoid structural simplification, blue gum high forest needs variability of fire intensity, season and frequency. This produces a mosaic of disturbance that maintains the biodiversity characteristic of blue gum high forest (Buchanan 1989). A mosaic of areas burnt at different times and unburnt areas has been implemented at St Ives through a program of prescribed burns (Figure 5). Mosaic burning has the following benefits:

- Designated sections, such as rainforest habitat gullies and vegetation on creek lines, are protected in unburnt areas.
- Some areas always remain unburnt, to provide habitat and an adequate food supply for fauna.
- The burnt area is kept to a suitable size for bushland regenerators to maintain.
- Each area is burnt a number of years apart, allowing structural diversity in the regenerating flora.

Site preparation

The intention of prescribed burning at St Ives is to create a high intensity surface fire to reduce the area to an ash-bed (Figures 6 and 7). In general, low intensity burns that do not burn the area to an ash-bed are not favoured, as weed species are likely to survive in the unburnt sections and will easily out-compete natives in the post-fire recovery phase. Low intensity fires also result in relatively little native seed germination in blue gum high forest.

To achieve a high intensity surface fire, primary weed management was undertaken prior to burning. Lantana and privet were cut down, their stumps painted with herbicide, and the weeds piled. Weed piles were then spaced throughout the prescribed burn area and left to dry (Figure 8). When the fire was lit, the weed piles produced a high intensity burn thereby promoting the germination of canopy, mid-storey and ground cover species. In between the weed piles the fire was cooler. This heat variability encourages a diverse range of responses from the soil seedbank.

Weed piles should be no higher than 1 m, as this may result in a fire that burns too hot and may sterilise the seedbank under the centre of the pile (DEC 2005b).

Due to logistical and safety constraints associated with prescribed burns, it may be some time after the primary weed clearing before the fire is possible. Therefore, it is imperative that follow-up

Photo: BARRC

Figure 6: Prescription burn at a manageable height from the canopy

Photo: BARRC

Figure 7: Surface reduced to an ash-bed

Photo: BARRC

Figure 8: Site prepared for an ecological burn with weed piles

Photo: BARRC

Figure 9: Area prepared for an ecological burn some years previously

Photo: BARRC

Figure 10: Regeneration two months after fire

weed maintenance occurs, which secures the site with dominant native regeneration until a burn can be conducted. Figure 9 shows an area prepared for ecological burn some years previously; due to follow-up maintenance a native understorey has grown, thereby securing the site against further weed infiltration until a time when a prescribed burn is permitted.

Post-fire maintenance

Post-fire maintenance provides an excellent opportunity for weed removal. This requires skilled people working at a slow pace to target weed seedlings without harming the fragile regenerating native plants. Post-fire maintenance is important in ensuring native seedlings are able to take hold as weed species can also respond well to fire (Figure 10). If post-fire maintenance is not scheduled then the prescribed burn should not go ahead.

Post-fire maintenance usually begins two months after the burn when the weeds can be easily identified. Access into the burnt zone should be controlled immediately after the prescribed burn, as the regenerating seedlings are in a fragile condition. Figure 11 shows regeneration of native canopy and mid-storey plants five years after fire.

Photo: N. Colman

Figure 11: Regeneration five years after fire

3.2 Weed management

Prescribed burns tend to promote canopy and mid-storey regeneration; manually removing weeds tends to promote the recovery of ferns, herbs, grasses and orchids. Bush regeneration focuses on areas that are relatively free of weeds, and then works towards areas of high weed infestations. Bush regeneration works at a pace that allows native vegetation time to establish.

The three phases of weed control

There are three phases of the weed control program: primary, consolidation and maintenance.

Phase 1: Primary. The bulk of the weeds are removed section by section.

A common mistake when primary weeding is to remove the canopy weed species first, without considering the effect of the increased level of sunlight to the ground layer and mid-storey vegetation below. It is an effective use of time to remove the weed species in these lower layers first and to encourage native species regeneration. This will ensure the desired response due to the increased levels of sunlight when the canopy weeds are eventually removed (BARRC 2007).

Phase 2: Consolidation. Weed removal causes soil disturbance which promotes both native and weed seed germination. Follow-up weeding must be undertaken to prevent weeds outcompeting native seedlings (Buchanan 1989).

Phase 3: Maintenance. Generally, as regenerating natives become established, the need for maintenance lessens. However, as the blue gum high forest at St Ives is surrounded by established dwellings, invasion of weeds from neighbouring areas is ongoing. In particular, birds such as pied currawongs (*Strepera graculina*) spread weeds through their faecal material after feeding on local weeds such as privet and lantana. Consequently, a level of maintenance will always be required at St Ives (Figure 12).

Weeding techniques

Prioritising which weeds to focus on is based on the potential of the weeds to spread and their impact on native vegetation. Low priority weeds include broad-leaved privet, which takes considerable time to mature and fruit; therefore, juvenile plants do not all have to be removed immediately. In contrast, high priority weeds are quick to establish and reproduce and thus have a devastating effect on native bushland. These weeds are constantly searched for and destroyed within the reserve. Such weeds include madeira vine, corky passionfruit vine and trad.

Figure 12: Bushland regeneration in progress

Madeira vine (*Anredera cordifolia*) is a highly invasive strangling vine. Removal involves scraping the main stem of the vine and painting with herbicide. All large aerial tubers within reach along the vine are also removed. Removing these tubers allows the herbicide to travel further up the vine to infect the smaller tubers closer to the top of the vine. Monitoring is required to ensure that the vine is killed (Blue Gum High Forest Group 2007).

Corky passionfruit vine (*Passiflora suberosa*) is another highly invasive strangling vine with its seeds spread by birds. If left unchecked this South American native can quickly overwhelm mid-storey and ground cover vegetation; it regenerates strongly after fire and can easily outcompete natives. Care needs to be taken during removal as the vine breaks easily. Scraping the vine and applying herbicide is the favoured removal technique (BARRC 2007).

Trad is an aggressive creeper that had carpeted entire sections of the blue gum high forest at St Ives. If trad is not completely removed and native plants regenerate, it is difficult and time consuming to remove from between regenerating native plants. The following steps were taken to remove it at St Ives.

- A sediment fence was installed to contain the spread of trad (Figure 13).
- The trad was raked to bare soil, with all native ferns and vines cut back prior to raking to avoid uprooting them.
- As trad is able to regrow from stem fragments, every fragment was carefully collected.
- Leaves and branches were scattered over the raked area. This forces any regenerating trad to grow through the scattered material, making it noticeable and ensuring its removal during the maintenance phase.
- To dispose of the trad, it was moved to a sunny position and covered in black plastic. The heat trapped under the plastic kills the trad which then decomposes.

Special care needs to be taken when weeding near native cherry (*Exocarpus cupressiformis*), a 2–6 m tall tree that can be found in blue gum high forest. As it parasitises the root systems of host plants, no weeds can be poisoned within close proximity. Instead, each weed should be cut to ground level and a tin placed over the stump to prevent regrowth.

Photo: BARRC

Figure 13: Sediment fence running through a section of the blue gum high forest preventing the spread of trad

Photo A. Kwok

Figure 14: Temporary barrier of privet

Weeds as protective barriers

Weeds such as privet and lantana have been left temporarily in dense stands along the edges of the reserve (Figure 14) for the following reasons:

- **as a physical barrier** to prevent weeds from entering the reserve via the adjacent urbanised area
- **to protect areas** by preventing both unnecessary human traffic into the reserve and the formation of new tracks through sensitive regeneration areas – this is especially important during post-fire regeneration.

Sediment fences

Sediment fences act as physical barriers preventing weeds such as trad, and invasive perennial grasses, such as panic veldtgrass (*Ehrharta erecta*), from entering the forest. They may also contain infestations within the reserve enabling easier interface between bushland and the urban areas (BARRC 2007) (Figure 15).

Photo: A. Kwok

Figure 15: Sediment fence along the border of the reserve preventing the spread of panic veldtgrass

Photo: A. Kwok

Figure 16: Emergent eucalyptus canopy species entwined in native vines

Treatment of competitive native vines

Native vines of blue gum high forest regrow quickly after disturbance and will strangle young native canopy and mid-storey vegetation (Figure 16). Treatment does not require killing the native vine, but merely cutting it away from the tree, thereby giving young trees time to establish (Blue Gum High Forest Group 2007; BARRC 2007).

3.3 Fauna management

Bird species play a vital role in maintaining ecosystem health. Certain birds eat insects that would otherwise feed on the trees. For example, insects known as lerps drink the sap from leaves; if the lerp population is allowed to increase this can cause dieback and death of canopy species (Collett 2001).

Tip: Install artificial nesting boxes as a substitute for tree hollows, which are very slow to form. Nesting boxes can be used as habitat by a variety of native birds and animals.

Exotic plants such as lantana, privet and blackberry provide habitat and foraging resources for birds and other fauna; therefore careful consideration must be taken during the removal of these weeds, to retain functioning habitat for native fauna. This can be achieved by the following approaches.

Work to an appropriate time frame that allows native trees and shrubs to replace the weeds that have been removed.

Observing carefully before weeding to detect bird and ringtail possum nests in exotic plants.

Maintain habitat by only working small manageable areas at a time, leaving stands of 'care-taker' weeds behind. Observe which weeds birds favour; this ensures that the correct care-taker weeds are left. As many bird species feed on and among logs and leaf litter, branches and dead trees should be left on the ground. Nesting hollows for birds and possums in many cases need to be provided as old natural hollows often do not exist. Also, debris needs to be present on the ground as refuge for many insects, invertebrates, small mammals and reptiles.

Use fire as a tool for maximum response of mid-storey and canopy species to regeneration.

Leave behind structures such as branches and dead trees on the ground as many bird species feed on and among logs and leaf litter.

Create fauna habitat by building a raft of branches and logs in a circular pile with weeds, such as lantana, on the raft which then decomposes off the ground.

Tip: Plant native vines next to clumps of lantana which have been cut and painted with herbicide. The vines will grow over the framework of the lantana, maintaining and improving fauna habitat.

Restoration of vegetation after weed eradication

Once weeds have been removed, regeneration is necessary to restore the forest to its earlier condition.

Due to low seedbank resilience in certain sections along the perimeter of the St Ives Blue Gum High Forest, replanting was required. Replanting aided in the formation of bushland corridors linking this reserve to other bushland areas and also created a native plant buffer that 'sealed off' the edge of the remnant from excess wind and sunlight, thereby reducing the infiltration of weeds.

Seed was collected by bush regenerators from the forest and either grown to tubestock in Ku-ring-gai Council's nursery or sown directly. Planting local provenance is advantageous as the plants have adapted to local climatic and soil conditions (DEC 2005b).

Planting techniques

When planting tubestock:

- give all seedlings a thorough watering the day before planting
- plant at the same depth in the soil as each seedling was in the container
- place water crystals within the root zone of the plant to aid water retention
- give seedlings a good soaking after planting to remove any air pockets in the soil
- install tree guards around the seedlings to protect the plants from predation and extreme weather (Figure 17).

Photo: A. Kwok

Figure 17: Replanting blue gum high forest trees grown from locally sourced seed

Tip: Collect seeds of native grasses and ground covers from blue gum high forest and sow them directly into the soil:

- lightly scrape back the soil
- scatter the seeds
- cover with a light sprinkling of soil
- water in lightly.

Manual soil disturbance to promote germination

Brush turkeys (*Alectura lathami*) have been sighted in the St Ives forest. They feed on insects, seeds and fallen fruits, which they expose by raking the leaf litter. This gentle disturbance promotes germination of the seedbank (Australian Museum 2003). Blackbutt seedlings can establish in bare and sunny areas (Buchanan 1989), so raking back leaf litter to bare small patches of soil underneath mature blackbutt canopy will promote the germination of their seeds.

Soil pathogens

Phytophthora cinnamomi is a microscopic soil-borne organism that can survive in very small quantities of soil for long periods of time. It kills a wide variety of native and non-native plant species by rotting the roots of its host. It is listed as a Key Threatening Process under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* (DECC 2008). The risk of spreading *P. cinnamomi* can be minimised by appropriate hygiene procedures.

Tools, machinery, boots and tyres are to be regularly drenched in a solution of disinfectant with all traces of soil washed off. When planting a number of plants, disinfect tools before and after each individual planting. *P. cinnamomi* can persist in dead organic tissue of the trees it has infected for many years. Infected vegetation is to be disposed of carefully. *Never* woodchip vegetation suspected of being infected by *P. cinnamomi*. DEH (2006) describes in detail the management of communities infected with *P. cinnamomi*.

Tip: When working in the bush carry some disinfectant in a spray bottle and a scrubbing brush to decontaminate boots and equipment when moving between sites, or if unexpected pathogens are encountered.

3.4 Stormwater control

Long-term successful site management requires that all water that flows onto the site be managed. High velocity stormwater that flowed into the reserve eroded the creek bank and brought refuse such as silt, nutrients and weeds thereby creating conditions where weeds could proliferate. Solely focusing on weed removal from the stormwater affected area would not be an effective use of time as more weeds and nutrients would be deposited after rain (BARRC 2007).

Photo: A. Kwok

Figure 18: Sandstone armouring of the creek preventing erosion and reducing the force of the water

Photo: A. Kwok

Figure 19: All non-essential tracks closed off to allow for regeneration

A gross pollutant trap was installed to filter the stormwater. The trap filters sediment, weeds and rubbish, while at the same time slows the velocity of water. The sediment trap needs to be cleaned once each year.

Additionally, sandstone boulders were placed below the sediment trap to minimise further creek bank erosion. These rocks dissipated water pressure, permitting natural litter traps to form in the creek below. Natural litter traps consist of sand, silt and fallen branches that naturally slow and filter the water (Figure 18).

3.5 Access management and community awareness

Access is kept to well-defined tracks in blue gum high forest at St Ives. All non-essential tracks have been closed to allow natural regeneration of the community. Tracks were blocked with boulders or logs and warning signs were installed (Figure 19).

Mowing

Areas underneath canopy trees in residential gardens, especially on the border of the blue gum high forest at St Ives, should *not* be mown, as mowing prevents the seedlings of blue gum high forest species from establishing (Figure 20). Weeding and not mowing promotes the growth of canopy and other blue gum high forest vegetation that may still be in the seedbank (Lewis 2001).


Photo: A. Kwok

Figure 20: Mowing underneath blue gum high forest canopy preventing native regeneration of the area

Council nursery program

To promote blue gum high forest regeneration, Ku-ring-gai Council has introduced a Backyard Bushcare Program which focuses on regenerating native vegetation on private land. Ku-ring-gai residents can obtain help to protect and regenerate blue gum high forest on their own land. Bushcare officers visit residents participating in the program and offer:

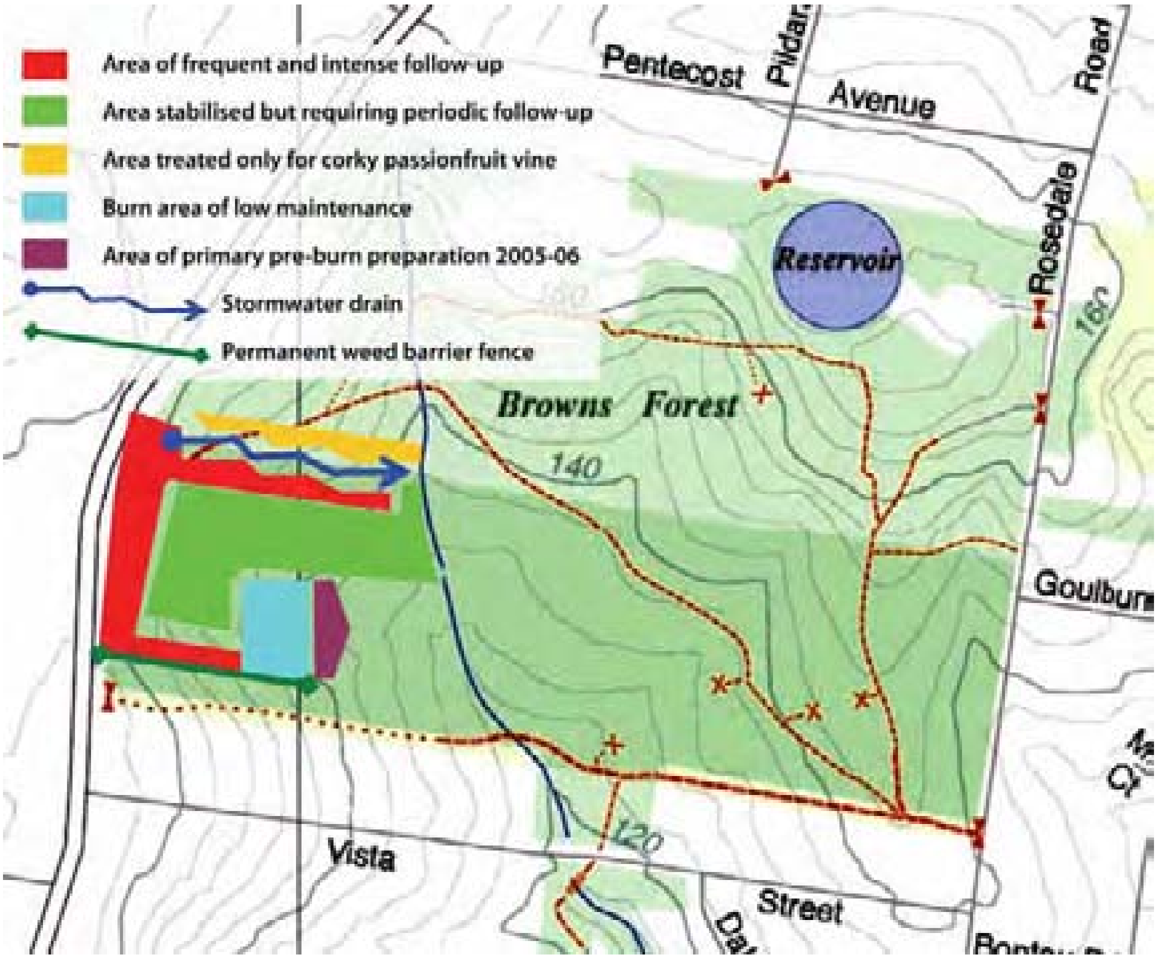
- free expert advice
- practical training
- realistic action plans
- help with regeneration work
- ongoing support.

For more information call the Backyard Bushcare team on 9424 0933 or send an email to backyardbushcare@kmc.nsw.gov.au.

3.6 Monitoring

Monitoring involves observing the changes that take place before, during and after restoration work (Underwood 1991). Keeping comprehensive records provides information on the effectiveness of management practices, allowing land managers to determine if the natural vegetation is improving or declining (DEC 2005b). Monitoring of the St Ives blue gum high forest included the following.

- **Before and after photographs.** Permanent monitoring posts (star pickets) were installed at the corner of the 5 m x 5 m monitoring quadrats. Pre- and post-treatment photographs were taken at regular intervals from these posts. This allows visual documentation of the vegetation regrowth after the controlled burn or bush regeneration practices.
- **Native plant and weed counts.** Periodically recording the diversity and abundance of weed and native plant species within each 5 m x 5 m quadrat before and after treatment provides a quantitative account of what was happening on site. The bush regeneration management practice employed was also noted. Over time, this enables different techniques to be compared (McDonald et al. 2002).
- **Vegetation maps.** Mapping the area provided a visual representation of where the weed infestations occurred within the forest. Mapping also documents the type of regeneration strategies in a particular area thus providing a visual mapped history of the forest (Figure 21).
- **Documenting and reporting.** Clearly specifying the desired ecological objectives and documenting the actions taken provides the basis for evaluating progress, correcting mistakes and ensuring ongoing success. Good data management will also provide useful information for other groups about successful restoration activities and guide restoration for other blue gum high forest remnants.



Source: Adapted from BARRC (2007)

Figure 21: Map of the maintenance and regeneration works

4 Summary of threatening processes and their management

Threatening processes of blue gum high forest	Management
Inappropriate fire regimes	Use fire frequency that allows native vegetation to reach maturity before reburning. Prepare burn area, use weed piles. Use a mosaic burn approach. Monitor the site before and after fire. Maintain the site after fire. Use a high intensity surface fire to encourage maximum germination of seedlings.
Weed invasion	Undertake bush regeneration. Manage competitive native vines. Install sediment fences to prevent further weed spread. Construct walking tracks. Monitor weeds before and after bush regeneration. Revegate from local provenance.
Absence of fauna	Work to an appropriate time frame Maintain fauna habitat when weeding.
Urban run-off	Install gross pollutant traps. Stabilise creek beds. Undertake public education for residents to limit damaging substances going into stormwater.
Inappropriate access	Close non-essential tracks using signage, boulders or logs. Undertake public education on the effects of mowing in preventing vegetation from germinating. Undertake neighbourhood education program on the conservation significance of the reserve.

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