Best practice guidelines

Cooks River Castlereagh Ironbark Forest

CMA Sydney Metropolitan Catchment Management Authority
STRATHFIELD COUNCIL
Australian Government
Department of Environment & Climate Change NSW

Cover photos: Coxs paperbarks – photo: Lyndsay Holme – Ringtail possum – photo: DECC

Published by:

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DECC 2008/601
ISBN 978 1 74232 042 7
November 2008
Printed on environmentally sustainable stock

Contents

Figures

1 Introduction

As Sydney has developed, much original native vegetation has been cleared or disturbed. As a result, many native plants and animals have become locally extinct, or there are so few of them living in isolated communities that they are threatened with extinction. These fragmented areas and threatened species need to be carefully managed to ensure their survival.

The Department of Environment and Climate Change (DECC) and Sydney Metropolitan Catchment Management Authority have identified the need to provide best practice guidance to land managers seeking to conserve Cooks River Castlereagh ironbark forest. Remnants of this ecological community exist only in Sydney and are endangered. This publication explains the best practice management strategies and techniques that have been used by Strathfield Council regenerators and volunteer bush carers to protect the remnant of Cooks River Castlereagh ironbark forest at Coxs Creek Bushland Reserve, Greenacre.

All current restoration projects for Cooks River Castlereagh ironbark forest should be managed to current best practice standards as inappropriate restoration can significantly affect the long-term viability of this ecological community.

1.1 Characteristics of Cooks River Castlereagh ironbark forest

Cooks River Castlereagh ironbark forest is an endangered ecological community of trees, shrubs, grasses and groundcovers native to the Sydney Basin Bioregion. It was once common in Sydney's western and south western districts, in areas with clay soils, derived from the nutrient rich alluvial deposits of ancient river systems (up to 65 million years old), or on Wianamatta shales soils. Where soil is shallower or more moist, other plant communities can arise in pockets or adjacent to Cooks River Castlereagh ironbark forest, such as Shale-Gravel Transition Forest (where the alluvium is shallow), Castlereagh Swamp Woodland (in moist depressions) and Castlereagh Scribbly Gum Woodland (on sandier soils) (NSW National Parks and Wildlife Service 2004 and DECC 2007).

Cooks River Castlereagh ironbark forest ranges from open forest to low woodland, with a canopy dominated by broad-leaved ironbark (*Eucalyptus fibrosa*) and paperbark (*Melaleuca decora*). The canopy may also include other eucalypts such as woolybutt (*E. longifolia*). The dense shrubby understorey consists of ball honeymyrtle (*Melaleuca nodosa*) and peach heath (*Lissanthe strigosa*), with a range of 'pea' flower shrubs, such as *Dillwynia tenuifolia*, hairy pea-bush (*Pultenaea villosa*) and gorse bitter-pea (*Daviesia ulicifolia*). The sparse ground layer is made of grasses and herbs, including kangaroo grass (*Themeda australis*), weeping meadow grass (*Microlaena stipoides* var *stipoides*) and wiry panic (*Entolasia stricta*) (NSW Scientific Committee 2002).

Photo: Lyndsay Holme

Figure 1: Ironbark trees at Coxs Creek Bushland Reserve

1.2 History of Cooks River Castlereagh ironbark forest

Aboriginal history

There is evidence that Aboriginal people were living in the Sydney region for at least 6000 years prior to European settlement. The Dharug people occupied land from what is now Sydney's inner west to the foothills of the Blue Mountains; a territory where Cooks River Castlereagh ironbark forest thrived. Campsites were located along the rivers and tributary creeks, taking advantage of the wide variety and abundance of plants and animals found across the region.

Fire was used by Aborigines for cooking, repelling mosquitoes, sending signals, warmth and ceremonial purposes, depending on needs and the season. Fire was also used infrequently to burn larger areas to trap small mammals for food and to promote growth and flowering of tuberous plants such as orchids and lilies. These infrequent patchy burns were occasionally over-burned by larger more intense wild fires triggered by electrical storms. The result was a mosaic of burnt areas varying in size and intensity which also gave rise to a varying pattern of vegetation across the landscape, in turn, promoting different types of regrowth and a diversity of habitats and ecological niches for animals and plants (Benson and Howell 1995).

The Aboriginal social structure and culture of the Sydney region disintegrated dramatically within a few years of European settlement. One result of this cultural disruption was a dramatic change in the scale and use of fire with subsequent impacts on biodiversity in the region.

There is however conjecture as to the scale and frequency with which Aboriginal people manipulated the landscape with fire and other means to increase plant productivity. The diversity of natural vegetation can be explained by environmental factors but could also have been modified by human intervention creating a more diverse biota.

However as most clearing across the Cumberland Plain had been carried out by the 1830s and replaced by simple agrarian methods generally limited to a few introduced species, it is difficult to find clear evidence for this view (Benson and Howell 1995). One thing is certain, with such a major change in both attitudes to the landscape and the application of agricultural practices, fire regimes were altered dramatically.

Non-Aboriginal history

The relatively fertile soils, undulating topography and proximity to the settlements at Sydney Cove and Parramatta led to the vegetation of western Sydney being extensively cleared relatively soon after European settlement. This was one of the first regions in Australia where European methods of cultivation and grazing took place.

Forests that were not cleared for farms were initially stripped of their taller straighter trees for use in building bridges, roads and fences. After that, many of the remaining trees were felled to provide Sydney residents with firewood. Orchards were established on the fertile shale soils from as early as 1826. With the expansion of the railway network in the 1900s, most of the remaining forests were felled for suburban development.

After two centuries of rural and urban development by European settlers, only isolated pockets of native woodland and open forest remain, including that found at Coxs Creek Bushland Reserve in Greenacre.

1.3 Current distribution and status

Cooks River Castlereagh ironbark forest is considered to be one of the most threatened ecological communities in Australia and is listed as an endangered ecological community under the *Threatened Species Conservation Act 1995* (NPWS 2004). The community has been reduced to little over 1000 hectares or around 7% of its original distribution, with a further 6% remaining as scattered trees (NPWS 2000a, NPWS 2000b). Relatively large remnants of this endangered ecological occur in the Castlereagh and Holsworthy areas and, to a lesser extent in the Penrith, Blacktown, Liverpool, Auburn, Bankstown, Canterbury, Strathfield and Parramatta local government areas (NPWS 2001, Cufer 2001).

Today residential development, clay/shale extraction, fragmentation, the invasion of weeds, nutrient-rich stormwater run-off, rubbish dumping, inappropriate fire regimes and mowing of plants are causing this forest type to decline further.

As a result of historical and continuing pressures, remnants of Cooks River Castlereagh ironbark forest had reduced canopy cover and were weed infested before recent community-based efforts to regenerate them.

Photo: Lyndsay Holme

Figure 2: Suburban and industrial development has substantially replaced or enclosed Sydney's original bushland

2 Coxs Creek Bushland Reserve demonstration site

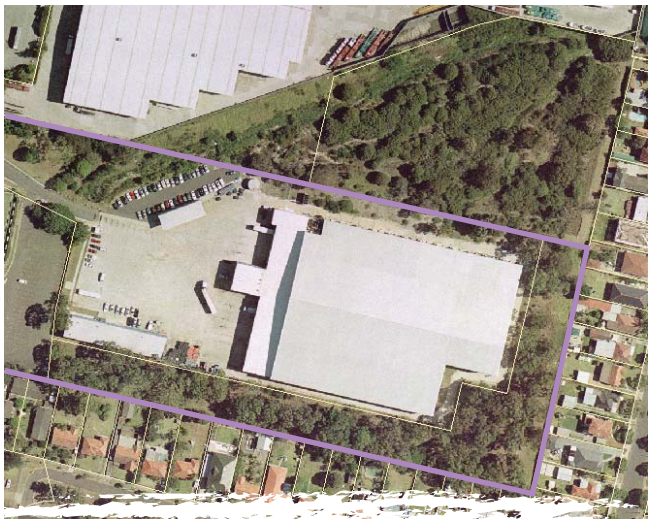

Photo: Land and Property Information NSW, 2007

Figure 3: Coxs Creek Bushland Reserve from the air. Roberts Road Reserve is the strip of bush to the east and south of the large white building

Coxs Creek Bushland Reserve is a 1.65 hectare area of Cooks River Castlereagh ironbark forest remnant bushland located in the suburb of Greenacre, approximately 14 kilometres south-west of Sydney CBD. The Reserve is located in an older, mixed residential and industrial area in the south of Strathfield Municipality and has gated access from Sylvanus and Drone Streets. An adjoining land parcel of 0.29 ha, owned by Colonial First State Investments is also managed as part of the bushland reserve.

Coxs Creek Bushland Reserve was formerly owned by the Australian Telecommunications Commission (Telecom now Telstra). In the early 1990s, the Telecom site retained a considerable area of remnant bushland. This land was dedicated to Strathfield Municipal Council by Telecom in early 1994, to be managed as a bushland reserve. Adjacent to the Reserve is a transport company which operates on part of the former Telstra land parcel, the former Bankstown Sewage depot site, which is now managed by a smallgoods manufacturer and the Roberts Road Reserve which lies within the borders of Bankstown Council and also contains some remnant bushland. Private residences border the eastern and southern boundary of the Reserve.

Coxs Creek is a tributary of the Cooks River; a 23 kilometre-long modified river channel passing through a highly urbanised catchment before emptying into Botany Bay. Strathfield Council is located in the upper Cooks River catchment which includes four major drainage lines. Coxs Creek links to the Punchbowl Road line which drains a catchment of 8.8 square kilometres into the Cooks River at Water Street, Strathfield.

The existing water course comprises a series of stormwater drains west of Roberts Road, and has been re-routed from the original creek line through the Reserve, re-entering an enclosed stormwater pipe at the north-east corner of the Reserve near the Drone Street entrance. The original creek drained paper bark swamps, which were once located near the Roberts Road–Juno Parade intersection.

Photo: Land and Property Information NSW

Figure 4: Greenacre in 1943 (left) and 2007 (right). In 64 years, the already greatly reduced native forest of the area has almost completely disappeared

2.1 Threatened plants and animals recorded at Coxs Creek Bushland Reserve

As well as hosting an endangered ecological community, the Reserve provides an important habitat for endangered animals and plants.

Photo: DECC

Figure 5: Green and golden bell frog

Photo: M.Fagg, Australian National Botanic Garden

Figure 6: Downy wattle

Photo: Sandy Sheltema, Australian Ecosystems

Figure 7: Tadgell's bluebell

Green and golden bell frog (*Litoria aurea*)

The green and golden bell frog was once among the most common species of frog throughout the most populated areas of Sydney. Today, it is one of the most threatened. In recent decades populations have been afforded some protection at a number of disused industrial sites such as old brick pits containing modified water bodies. Green and golden bell frogs have been seen in Coxs Creek Bushland Reserve in recent years, but only in small numbers. In some years, they cannot be found at all. Fluctuations would have been a natural occurrence before the human settlement of the region, when frogs would have occasionally become extinct in some ponds while recolonising others. A plan of management is in place to try to ensure that the green and golden bell frog persists in the vicinity of the Coxs Creek Bushland Reserve (DECC 2007).

Downy wattle (*Acacia pubescens*)

Downy wattle is a bushy spreading shrub with brilliant yellow flowers. It has fernlike foliage and grows to 1–4 metres (Robinson 1994). This species is listed as vulnerable in the *Threatened Species Conservation Act 1995*. Acacia species generally have high seed dormancy and long-lived persistent soil seedbanks (Auld 1996). The most appropriate fire regime for downy wattle is currently unknown. However, fire intervals that are too long are likely to have a detrimental effect (DECC 2005a).

Tadgell's bluebell (*Wahlenbergia multicaulis*)

Tadgell's bluebell is a small herb with beautiful blue flowers. The population in Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs is listed as threatened with only an estimated 40 to 50 plants remaining (NSW Scientific Committee 2003). Although it is a delicate plant which cannot withstand repeated disturbances, Tadgell's bluebell seeds may be stimulated to germinate by disturbance of the soil and high exposure to sunlight.

Photo: DECC

Figure 8: Nodding geebung flowers

Photo: Strathfield Council

Figure 9: *Allocasuarina glareicola*

Nodding geebung (*Persoonia nutans*)

The nodding geebung is an erect to spreading shrub up to 2.5 metres high. It is rather inconspicuous except when flowering. Flowers are yellow pendent shaped and drooping. The flowering period is from December to March (Robinson 1994). Plants of this species resprout from soil stored seeds after fire (Keith & Bradstock 1994).

The fruit of Persoonia species were a favourite for Aboriginal people. The fruiting period was a seasonal marker indicating that marsupials such as possums, bandicoots and wallabies could be caught feeding in the area (Wreck Bay Community & Renwick 2000; Mason 2001).

Allocasuarina glareicola

A. glareicola is an endangered she-oak shrub, 1–2 m high, with 20 cm branchlets. Cones are 10–13 mm by 7–8 mm. A. glareicola is not killed outright by fire but resprouts from the rootstock. The time taken for the plants to flower and set seed is not known, but only those plants growing in areas unburnt for some time produced substantial quantaties of fruit (DECC 2005).

2.2 Past and present condition of the Reserve

Before restoration work began in 1996, the Coxs Creek Bushland Reserve was subjected to rubbish dumping, clearing, damage from vehicles and impact from storm water surges. Bush regenerators from Strathfield Council and Friends of Coxs Creek Bushcare Group were confronted with a disappearing canopy and weeds which dominated entire sections of the Reserve and made up more than a third of the total number of species recorded. The current condition of bushland within the Reserve varies according to distance from tracks, grassed clearings and drainage lines. Disturbance (burning, flooding, vandalism and dumping) in core bushland areas is reflected in micro-site degradation.

Introduced plants included woody weeds such as green cestrum (*Cestrum parqui*) and Mickey Mouse bush (*Ochna serrulata*), previously dominated the mid-storey. Ground covers such as ground asparagus (*Protasparagus aethiopicus*), and grasses such as kikuyu (*Pennisetum clandestinum*), common couch (*Cynodon dactyl*) and panic grass (*Ehrharta erecta*) were also abundant. Blackberry (*Rubus fruticosus*) is still present on the creek banks and in the drainage swales, while introduced vines such as moth vine (*Araujia sericifera*) and bridal creeper (*Myrsiphyllum asparagoides*) are widespread in the core bushland. Thanks to monthly visits by Strathfield Council bush regenerators and the Friends of Coxs Creek Bushcare Group, weeds are now being managed at the site.

Many of the weeds in the Reserve are typical of urban bushland where the natural fire regime has been suppressed for many years. The accumulation of natural leaf litter, the influx of stormwater, along with the absence of fire have promoted a gradual increase in soil nutrient levels, thereby providing conditions which favour the establishment of mesic (soft-leaved), moisture-loving garden escapees (Urban Bushland Management 2001).

In the creek and drainage line, high levels of plant nutrients and deposition of silt has encouraged the growth of native *Typha* and *Juncus* species and a range of introduced aquatic weeds. These plants have acted to 'choke out' many of the locally native aquatic plants and have affected the water quality. Flooding during heavy rain has been instrumental in dispersing weeds from the weedy creek line into the core bushland (Urban Bushland Management 2001).

2.3 Bush regeneration at Coxs Creek Bushland Reserve

Activities carried out by the Coxs Creek Bushcare Group with the assistance of Strathfield Council have included bush regeneration, frog pond construction for the endangered green and golden bell frog, seed collection for raising seedlings and planting of endemic tube stock back into the Reserve. Strathfield Council contract bush regenerators continue to support the Reserve with weed control, prescription burning, mitigation of stormwater flows, improvements to water quality, restriction of vehicle access and rubbish removal.

Strathfield Council has been awarded two environmental awards for its management of the Reserve:

- First prize in the Urban Greening category of the Keep Australia Beautiful Metro Pride Awards 1996
- Winner in the Local Government and Shires Association of NSW Excellence in the Environment Awards 1998.

Photo: B Walters

Figure 10: Bush regenerators weeding at the edge of the Reserve

Planning and site assessment

Strathfield Council has prepared a Plan of Management for Coxs Creek Bushland Reserve. This document sets out clear objectives (Strathfield Council 2001) such as:

- a thorough site assessment including an assessment of resilience
- strategies for ecological restoration
- incorporation of legislative requirements
- site monitoring and evaluation of restoration methods.

For more detail on plans of management relating to a variety of Cumberland Plain woodland forms, see the Department of Environment and Climate Change publication *Best Practice Guidelines for Bush Regeneration on the Cumberland Plain* (DECC 2005).

3 Guidelines for bushland managers and bush regenerators

The main aim of bush regeneration is to restore and maintain an ecosystem in which natural regeneration can occur (Buchanan 1989).

Successful management practices focus on treating the causes of problems, rather than focusing on specific symptoms. For example, managing weed infestations should focus on managing the sources of weed including urban runoff, disturbance by human activities (e.g. rubbish dumping), or prolonged absence of fire. Unless the causes of a particular problem are identified and managed, threats to bushland integrity such as weeds will continue to occur.

Successful best practice methods implemented at the Coxs Creek Bushland Reserve include:

Weed management: Removing weeds by hand creates soil disturbance that tends to favour the regeneration of native groundcovers and shrubs.

Fire management: Prescribed burns in the form of pile burning are used to aid in the regeneration of canopy, mid-storey and groundcover trees and to control weeds.

Fauna Management: Wherever possible habitat for fauna is maintained even, if necessary, with the retention of introduced plants and items of rubbish.

Stormwater control, stream bank restoration and pond construction: Engineering works filter stormwater and minimise creek bed erosion and provide habitat for the green and golden bell frog.

Monitoring and maintenance: Ongoing monitoring ensures techniques undertaken in previously-worked areas are effective. Monitoring includes documenting the regeneration of native and weed species after use of a particular bushland regeneration technique. Previously worked areas are continually maintained to keep them weed free.

Community awareness: Bushland managers and practitioners strive to engage local residents, neighbours and workers from nearby factories in conservation issues relating to the ecological community found in the Reserve.

3.1 Protecting the Cooks River Castlereagh ironbark forest seed bank

Many Cooks River Castlereagh ironbark forest species can survive for decades as seeds stored in the soil—the seedbank. Even if the remnant appears weedy and degraded, it may still contain seeds that can regrow. Regeneration from the seedbank is most likely to take place if the soil profile has remained undisturbed.

The soil seedbank is the key to regeneration. The appropriate use of fire and weed removal can initiate seed germination and help the original vegetation to recover. At some sites other 'trigger' practices can be highly effective and include the use of smoke water, brush matting and soil disturbance (the raking back of leaf litter and gentle turning of the soil). Allowing an area to recover by natural regeneration (without planting) for as long as practicable is the preferred method.

When the seedbank has gone and the forest cannot regenerate, planting helps recover some of what has been lost. Seedlings grown from seeds collected from nearby remnants can help maintain a site's genetic integrity (DECC 2005). In addition, if land is available, corridors can be created to relink isolated forest remnants or replace the understorey in patches where only trees remain. This is not possible for Coxs Creek Bushland Reserve as it is surrounded by residential and industrial development.

3.2 Weed control and restoration

Cooks River Castlereagh ironbark forest is found in soils that are richer in nutrients compared to other soil types in the Sydney Basin. Exotic weed species spread by birds, insects, mammals, wind and water can easily establish in these soils. Without successful long-term weed management, invasive plants would eventually dominate the understorey and mid-storey. Over a number of years this would eventually lead to remnant bushland to be replaced by exotics.

The three phases of weed control

Phase 1: Primary The weeds are removed section by section, moving from areas that are relatively free of weeds into areas of high weed infestation. This technique minimises the spread of weeds into wider areas by reducing the weed source (Buchanan 1989). Bush regeneration works at a pace that allows native vegetation time to re-establish.

A common mistake when primary weeding is to remove the canopy weed species without first considering the effect that increased sunlight and warmth may have on the vegetation below. For instance, removing narrow-leaved privet (*Ligustrum lucidum*) in Cooks River Castlereagh ironbark forest remnants can open up the area to other invasive annuals and ground cover weeds such as panic grass and trad (*Tradescantia fluminensis*). It is better to remove weed species closest to the ground first in order to encourage native regeneration.

Phase 2: Consolidation Weed removal causes soil disturbance which promotes both native and weed seed germination. There can also be a risk of erosion after weeding, especially on sloping terrain. The area should not be worked heavily again for some months but follow-up weeding may be required to prevent weeds out-competing native seedlings (Buchanan 1989).

In some instances resprouting weeds can offer a temporary shield to the native seedlings from harsh conditions. However, it is important to remove weeds before they produce seeds.

Phase 3: Maintenance As regenerating natives become established, the need for maintenance lessens. However, as Coxs Creek Bushland Reserve, like many reserves, is surrounded by development and modified landscapes, weed invasion from neighbouring areas is an ongoing threat. In particular, birds spread weeds through their faecal material after feeding on local weeds. Consequently, a level of maintenance will always be required for this site.

Minimising herbicide use

The use of herbicides is often necessary tool in the control of weeds within bushland remnants. Spot spraying should be considered only after careful spray preparation of the target area, and should be restricted to the edge of remnants. No spraying should be conducted within 5 to 10 metres of any *Allocasuarina glareicola*, nodding geebung, downy wattle or Tadgell's bluebell. Spot spraying can be undertaken selectively and with care close to water bodies if there is no alternative.

Herbicide use within remnants should be restricted to the 'cut and paint' or 'scrape and paint' method. This method is often required on sloping sites and near streamlines where hand-pulling weeds will result in disturbance to the soil and subsequent erosion. In general, however, hand weeding is recommended.

Buffer zones and adjoining vegetation

The restoration and maintenance of a suitable native vegetation buffer around the site can be necessary for long-term viability of the remnant being protected. At times the buffer may comprise non-Cooks River Castlereagh ironbark forest bushland established to minimise detrimental edge effects such as increased runoff, rubbish dumping, weed encroachment and other disturbances to the integrity of the bushland remnant.

Buffers are crucial for the continued ecological health and function of remnants. Clearing needed for fire hazard reduction should ensure this buffer is maintained. The size of the buffer should be as large as possible. The larger the buffer, the less edge effects will impact on remnants.

Photo: Strathfield Council

Figure 11: Sediment fence weed barrier in place

Planting in the buffer zone

Where there is little or no native seedbank present, it may be appropriate to replant in degraded buffer areas adjacent to Cooks River Castlereagh ironbark forest. Planting from locally sourced seed is advantageous as the plants have adapted to local climatic and soil conditions (DECC 2005).

Mulching within or adjacent to remnants should be avoided as it will prevent any native seedbank from germinating and can potentially introduce damaging fungus species to the site.

Sediment fences

Sediment fences or silt fences are an excellent way to prevent ground cover weeds, such as invasive perennial grass (e.g. panic grass), from entering the remnant. They can also be used to retain weeds where they are required for fauna habitat or to protect the soil from erosion while native plants re-establish themselves (Figure 11).

Soil pathogens

Phytophthora cinnamomi is a microscopic soil-borne plant pathogen that can survive in very small quantities of soil for long periods of time. It kills a wide variety of non-native and native plant species (including Cooks River Castlereagh ironbark forest species) by rotting the roots of its host. Plants in degraded habitats are particularly susceptible to *Phytophthora* infection. Infected soil can also be brought in on equipment, boots or tyres. Prevention and limitation of the spread of *Phytophthora* is the most effective means of control (Royal Botanic Gardens Trust 2007).

Control methods include:

- Sanitation of tools, machinery – Tools are to be regularly drenched in a solution of detergent or disinfectant with all traces of soil washed off. A large drum containing this solution should be placed in a convenient place in the depot and tools should be regularly brought back, washed and drenched to remove soil. When planting a number of plants, disinfect tools before and after each individual planting in a portable container of disinfectant.
- Boots and tyres – Soil clinging to boots and tyres is a common vector in transporting *Phytophthora*. To limit the spread of the pathogen, ensure that all soil is scrubbed clean with a solution of detergent or disinfectant. A 1% solution of bleach or a 70% solution of methylated spirit is also suitable.
- Infected vegetation – *Phytophthora* can persist in dead organic tissue for many years. Dead roots and any above ground pruned material are to be disposed of carefully. This is especially important if the site's management practice is to remove weeds off site. Never woodchip vegetation suspected of being infected by *Phytophthora*.

3.3 Fire management practices in Cooks River Castlereagh Ironbark Forest

In the past, fire was considered to be harmful and destructive. However, it is now understood that many Australian plant communities depend on fire to maintain their diversity and vigour. (Buchanan 1989; Thomas 1994; McDonald *et al* 2002). Species that depend on fire for seed germination may become locally extinct in its absence. Equally, a high fire frequency is also capable of causing local extinctions (Gill & Bradstock 1995).

As Sydney's suburbs expanded and surrounded remnant bushland areas, the incidence of natural bushfires has been reduced or eliminated for many decades. Most Cooks River Castlereagh ironbark forest species regenerate after fire from lignotubers and buds beneath the bark as well as seeds stored in the soil (DECC 2005).

Benefits of fire

To maintain the ecological health of the Coxs Creek Bushland Reserve, ecological burning has been introduced in the form of prescribed 'pile burning'. With this method small piles of cleared, dry vegetation are systematically burnt with adequate ground staff and resources on hand to safely carry out the burn in optimal weather conditions. This procedure stimulates native regeneration and aids in weed control. After burning, regeneration is carefully monitored to assist in the planning of future prescription burning. By contrast, unplanned fires can be devastating to Cooks River Castlereagh ironbark forest and other bushland types.

The intention of prescribed burns is to create conditions favourable for seed germination. An appropriate fire regime will:

- increase the amount of sunlight reaching the soil
- encourage new growth of microbial flora and fungi that aids in the germination of seedlings
- release nutrients such as nitrogen and phosphorus into the soil which also aid in plant growth and vigour (Buchanan 1989)
- increase the diversity of species in communities that require fire for regeneration.

Fire variation – seasonality and mosaic burning in the Coxs Creek Bushland Reserve

Applying a fire regime that varies in frequency, duration, intensity and seasonality will maximise biodiversity outcomes (Bradstock *et al* 1995, Buchanan 1989). For example, vulnerable species found at Coxs Creek Bushland Reserve such as nodding geebung, *Allocasuarina glareicola* and downy wattle are at risk from high frequency fire. Therefore prescription burning should be scheduled for mild conditions in late summer and autumn, which is generally more favourable to post-fire seedling survival, rather than burning in winter and spring (Bradstock and Bedward 1992). Many species also set seed in spring which provides food for native animals. If the seed is damaged from burning then a potential food source is lost which then stresses native animal populations. However, the response of other Cooks River Castlereagh ironbark forest flora and fauna, in relation to fire season, is poorly understood.

To maintain the diversity that characterises Cooks River Castlereagh ironbark forest, fires of variable intensity and frequency must take place to create a mosaic of different-aged burnt and unburnt areas (Buchanan 1989). Minimum fire interval in an area scheduled for prescription burning is from 9 to 12 years and in adjacent areas at a minimum interval of from 3 to 5 years (DEC 2005) (Figure 12).

The benefits of mosaic burns are:

- increased structural diversity in the regenerating flora
- some areas remain unburnt, and provide habitat and food supply for native fauna
- burnt areas are kept to a suitable size for bushland regenerators to maintain.

Inappropriate fire regimes

Burning a Cooks River Castlereagh ironbark forest remnant too frequently can result in the loss of native plant species that are not given enough time to mature and set seed. This is especially important for the endangered plants nodding geebung, Tadgell's bluebell, downy wattle and *Allocasuarina glareicola*. The desired interval between fires is

Photo: Strathfield Council

Figure 12: Healthy native plant regeneration following the application of mosaic burning

Photo: Strathfield Council

Figure 13: A weed pile prepared for eventual burning. The black plastic is to sterilise any seeds with solar heat

Photo: Strathfield Council

Figure 14: Prescribed burn. Note the fire is kept to a manageable height away from the canopy

Photo: Strathfield Council

Figure 15: Reducing the surface to an ash bed gives the regenerating canopy and mid-storey native plants the greatest chance of success

between 9 and 12 years. Fire exclusion for a period of more than 30 years is likely to be detrimental (DEC 2005).

Other inappropriate fire regimes include:

- burning an area that is too large to be maintained by essential follow-up bush regeneration
- not ensuring sufficient habitat is left unburnt to provide adequate food and shelter for fauna
- failing to burn the ground litter and/or pile(s) of the target area to an ash bed, which may result in a proliferation of weeds in the partially burnt areas or where only low intensities have resulted.

Site preparation

Prescribed burning in the Coxs Creek Bushland Reserve aims to create a ground fire that reduces the burnt area to an ash bed (Figure 15). Low intensity burns that do not burn the area to an ash bed are not effective, as weed species are likely to survive in partially burnt or unburnt sections and will easily out-compete native plants in the post-fire recovery phase.

Before the prescribed burn takes place, woody weeds are cut near the base and the exposed area covered with herbicide. The removed weeds are placed into piles. Weed piles are spaced throughout the prescribed burn area and left to dry. It may be some time after the primary weed clearing before the fire is possible. If this is the case, it is essential that follow-up maintenance occurs to keep weeds under control.

During the burn, the weed piles produce a high intensity burn promoting the germination of native species (Figure 14). It is important to construct piles of different size, and (if possible) allow the fire to burn in between the piles, which results in a variety of temperatures and intensity across the fire ground. The heat variability encourages a diverse range of responses from the soil seedbank.

The weed piles should be long rather than high. Piles with maximum dimensions of 1 m high by 1.5 m wide and 2 m long disperse the heat effectively (DEC 2005). Piles over one metre high may result in a fire that burns too intensely and may sterilise the soil seedbank under the centre of the pile. Ensure weed piles are not placed under powerlines, close to fences, at the base of trees or under a low canopy.

Protection of life and property is always the primary consideration for controlling fire in an urban setting. However, fire suppression activities should be carried out with the minimum possible disturbance to vegetation.

There is a danger that areas burnt in a prescribed burning program might be re-burnt in unplanned fires (arson) or wildfires. This could lead to a decline or loss of plant species and stress to fauna. The site manager should ascertain if there is a potential for wildfires or unplanned fires.

Post-fire maintenance and monitoring

Fire can stimulate the germination of both weed and native seeds from the soil seedbank. Exotics have the potential to out-compete the regenerating native plants, rendering the prescribed burn futile. The following considerations are recommended to reduce the risk of weeds dominating the site.

- Soil disturbance caused by weed removal has the potential to disturb the regenerating native seedlings. It is advisable to allow the regenerating natives to become established before weed removal. However, weeds must be removed before they set seed.
- Post-fire maintenance requires people with plant identification skills to target weed seedlings without harming the fragile regenerating native plants.
- If post-fire maintenance is not possible then the prescribed burn should not go ahead. Native seedlings must be able to grow to maturity and set seed, otherwise the seedbank will become depleted.
- Monitoring ecological impacts of all fires (planned and unplanned) within the remnant allows land managers to evaluate and potentially modify fire management practices.

Fire management summary

- After a prolonged period (>30 years) without fire or similar disturbance, the ecological diversity of a bushland remnant becomes diminished.
- A high fire frequency will also reduce species diversity, and must be avoided.
- Pre and post-fire weed treatment is essential.
- Fire history records and maps need to be kept accurate and updated for Cooks River Castlereagh ironbark forests, both within and outside reserves. Because remnant sites are typically very small, this needs to be done with a high degree of detail. Contact should be made with the NSW Rural Fire Service or local council who may have fire history records.
- Late summer/autumn burns are more likely to result in successful regeneration of vulnerable species compared with winter/spring burns.
- Fire responses for many flora and fauna according to season are not well known although this is becoming better understood with further research.
- Avoid construction of additional fire trails or tracks or widening of existing tracks in areas containing Cooks River Castlereagh ironbark forest.
- Do not use wetting agents or chemical retardants in areas containing Cooks River Castlereagh ironbark forest.

Pre- and post fire checklist

- ☐ Obtain relevant authorisations and permits from the local council and, if necessary, DECC.
- ☐ Have adequate fire control measures in place, for example, a fire engine, traffic control measures and adequate human resources.
- ☐ Perform a pre-fire fauna search before burning. The fire plan may need to be modified as a result. For example, an area may not be burnt if it contains currently used bird nests.
- ☐ Notify neighbours of the intention to burn.
- ☐ Ensure the weather is appropriate for fire.
- ☐ Have a post-fire monitoring and maintenance plan.

Photo: Cheyne Ramsay

Figure 16: Ringtail possum (*Pseudocheirus peregrinus*)

3.4 Fauna management

Animals are an essential component of a healthy ecosystem. For example, some bird species eat insects that would otherwise feed upon the trees, causing dieback (Collett, 2001).

Care must be taken during regeneration to ensure that a functioning habitat for native fauna is retained. 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.

Observe 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 'caretaker' weeds behind to maintain habitat. Observe which weeds birds favour; this ensures that the correct 'caretaker' weeds are left. Leave logs and leaf litter on the ground as habitat for insects, invertebrates, small mammals and reptiles.

Rehabilitate creeks and ponds to provide a healthy habitat for aquatic invertebrates, small fish and frogs (including the threatened green and golded bell frog).

Consider the habitat potential of rubbish such as old pipes, tiles, car bodies and pieces of tin. These can be left temporarily as they provide habitat, especially when the rubbish is long established and away from public view (Ondinea, 1998). Allow time for fauna to adapt to naturally developed habitat at the rehabilitated site before rubbish is eventually removed.

Introduced animals

Both feral and domestic cats are regularly sighted in Coxs Creek Bushland Reserve. Cats disturb wildlife thus affecting their feeding and breeding, as well as posing a direct threat to small native animals, birdlife and potentially the green and golden bell frog. Neighbourhood liaison and education are the main management practices used to reduce this threat.

3.5 Stormwater control, stream bank restoration and pond construction

Long-term successful site management requires that all water flows into the site be managed. Weed removal alone from stormwater-affected areas would not be an effective use of time because more weeds and nutrients will be continually deposited after rain (BARRC 2007).

The Coxs Creek Bushland Reserve is subjected to periodic high volume discharges of stormwater along the existing modified streamline. This results in stream bank erosion and flooding of some sections of the Reserve. Flooding from urban run-off introduces unnaturally high nutrient levels and weeds which can seriously affect the resident fauna and vegetation.

Photo: Strathfield Council

Figure 17: Restored creekline at Coxs Creek Bushland Reserve

To mitigate these effects, sections of the channels have been lined with sandstone boulders which dissipate water pressure, permitting natural litter traps to form in the streamline below. These litter traps consist of sand, silt, rocks and woody debris that slow and filter the water in the same way that a natural stream system operates. These boulders have also been used to create pools that slow water flows and provide a habitat for aquatic invertebrates, small fish and frogs. Gross pollutant traps were installed at the Reserve boundaries to reduce the infiltration of litter, including plastic bags and bottles.

3.6 Monitoring and Maintenance of Cooks River Castlereagh ironbark forest

Ecological processes are complex. Therefore, when we implement bushland restoration practices, we do not always know exactly what the outcome will be. Thus, it is important to observe the changes that take place on site during and after bush regeneration, and to keep good records of these changes (Underwood 2001; Natural Heritage Trust 2004).

Monitoring is important for three main reasons:

1. It provides feedback on the effectiveness of management actions, and hence whether these actions need to be modified.
2. It allows land managers to see whether natural resources and individual plant species are stable, improving or declining.
3. It allows the impacts of different bushland regeneration practices to be compared.

Records should be consistent, comparable, and easily interpreted by any interested person. Types of documentation can include:

- before and after photographs from fixed points (grid referenced with GPS is useful). Photos can be taken at regular intervals to show change over time. Photos should be dated, annotated noting direction of views and detailing points of interest with points located on a topographic map
- aerial photos to record broad-scale changes
- vegetation maps
- flora and fauna species lists

Photo: Lyndsay Holme

Figure 18: Open days are a good way to generate community appreciation of ecological diversity in their neighbourhood

Photo: Strathfield Council

Figure 19: This footbridge across Coxs Creek is designed to blend into the natural landscape

- quantitative data through permanent quadrats and/or transects
- records of any new techniques being trialled
- reports that detail the original condition and threats to native vegetation, management actions applied, and outcomes from management.

3.7 Community awareness and access

Bushland managers and practitioners should strive to engage neighbouring residents and the wider community in conservation issues relating to the ecological community found in bushland remnants. By spreading the word about the relationship between people and their landscape, threats such as straying cats, live weed dumping and runoff can be minimised and the ranks of volunteers increased.

Some of the strategies employed to achieve these objectives at Coxs Creek Bushland Reserve include the following:

- The development of a comprehensive education and interpretive program, raising awareness and appreciation of the Cooks River Castlereagh ironbark forest remnants at Coxs Creek.
- Erection of educational signs at Coxs Creek indicating the conservation significance of plants and landscape features.
- Erection of information signs at the site prior to and during restoration works detailing the nature and purpose of the works.
- The gathering of information on the ecological community and the management actions to feature on the Strathfield Council website.
- The encouragement of small volunteer groups coordinated by Strathfield Council for monitoring and rehabilitation works.

Volunteers

The efforts of volunteers in the restoration of bushland in Sydney has long been acknowledged as a significant and valuable contribution. Many councils and land managers rely on volunteers to undertake bush regeneration and public education in and around their reserves. The work of volunteers should never be taken for granted, but nor should it be relied on completely for restoration works in endangered ecological communities. These areas are deserving of the expertise of professional bush regenerators who can carry out restoration works and assist and guide community groups.

Fencing

While it is important that the local community has a connection with the surrounding bushland, unregulated walking tracks and foot pads can lead to degradation and fragmentation of small remnants. For this reason it is preferable to minimise access to some Cooks River Castlereagh ironbark forest sites. This can be achieved through fencing. Fencing materials should be resistant to fire and should not restrict the movement of fauna.

Summary of bush regeneration practices

- Protect the soil seedbank; it could be the key to successful regeneration.
- Bush regeneration practices need to be tailored to the specific conditions of Cooks River Castlereagh ironbark forest.
- When carrying out bush regeneration consideration must be given to coordinating weed control and ecological fire management activities within the remnant.
- Minimise herbicide use to cut and paint methods. All native plants in an endangered ecological community are protected under legislation; care must be taken not to harm them.
- Appropriate buffers must be restored and maintained around Cooks River Castlereagh ironbark forest remnants.
- Phytophthora protocols must be followed when bush regeneration is being carried out.
- Plans of management are necessary for the long-term strategic management of Cooks River Castlereagh ironbark forest remnants.
- Only work in areas that are of a size that is able to be maintained.

4 Licences for activities within Cooks River Castlereagh ironbark forest

It is illegal to harm native wildlife under s.100 of the NPW Act (1974).

Bush regeneration, weed control, clearing for fire breaks, indeed almost any activity within a bushland remnant requires either a Section 91 certificate of approval, (*Threatened Species Conservation Act 1995*), or s132c licence (*National Parks and Wildlife Act 1974*) from the Department of Environment and Climate Change (NSW). Generally an s91 licence is required for actions that are destructive, while a s132c licence (Scientific Licence) is required for scientific and/or conservation purposes. The s91 certificate application is submitted to DECC via the Metropolitan Operations Branch at Parramatta and an application for a scientific licence via the Wildlife Licensing Section at Hurstville.

Where prescription burning, including pile burning, is being considered on private and public lands (with the exception of reserves managed by the NSW NPWS) within the Metropolitan area an Open Burning Approval Certificate must be obtained together with one of the above certificates from DECC.

More information can be found at:

www.environment.nsw.gov.au/threatenedspecies/S91tscalicenceform.htm

www.environment.nsw.gov.au/resources/nature/scientificlicenceapplication.pdf

Where burning is to occur on NPWS managed lands, the normal environmental assessment and certification procedures apply in accordance with the fire management strategy and plan of management guidelines for that land. Lodgement is with the relevant certifying authority via the Rural Fire Service (RFS Act 1994) Bushfire Risk Information Management System tool and notifications to the applicable local Fire District authorities (i.e. inner Metro areas notifications are via the NSW Fire Brigades; in outer metro areas are via the local Rural Fire Service Fire District).

5 Securing protection

Planning decisions at local government level are usually guided by local environment plans. These ideally should identify Cooks River Castlereagh ironbark forest remnants as environmental protection zones.

Private landholders managing Cooks River Castlereagh ironbark forest are encouraged consider registering the land under the DECC Conservation Partners Program. This program supports landholders in voluntarily protecting and managing native vegetation, wildlife habitat, geological features, historic heritage and Aboriginal cultural heritage on their properties.

Landholders can choose from a range of protection options which recognise and formalise their commitment to conservation on their properties. In turn, DECC provides support matched to the level of protection for the land.

The highest level of protection, a voluntary conservation agreement, is encouraged for Cooks River Castlereagh ironbark forest remnants. A conservation agreement is a joint agreement between landholders and the Minister for the Environment. The area under the agreement is registered on the title of the land, ensuring that, if the land is sold, the agreement and management requirements remain in place and the forest is protected in perpetuity.

More information can be found at: www.environment.nsw.gov.au/cpp/ConservationPartners.htm

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