WILLOUGHBY CITY COUNCIL

ECOLOGICAL BURNING

Reintroduction of appropriate fire regimes – One important approach by Willoughby City Council to the conservation management and restoration of the Cities bushland ecosystems

Introduction

- **Project name:** Willoughby City Council's ecologically sound hazard reduction program.
- **Aims:** To reintroduce natural fire regime cycles into fragmented and underburnt urban bushland areas - to encourage native plant regeneration and improved biodiversity conservation.
- **Location:** Willoughby City Council is located on the lower north shore of Sydney – approximately 7 minutes by car to the Sydney CBD (refer regional & Australian map below).
  The area has two catchments, Middle Harbour Catchment to the east and Lane Cove River Catchment to the west.
- **Vegetation and soils:** The bushland reserves of the Willoughby local government area (LGA) are predominately open sclerophyll forests occurring on soils of the Hawkesbury Sydney Sandstone complex bordered by harbour foreshore. Other Open sclerophyll forests occur on wianamatta shale and represent transitional pockets of bushland throughout the LGA. Much of this bushland is contiguous with larger natural areas to the west and north administered by the NSW National Parks and Wildlife Service (Lane Cove and Garrigal National Parks). Although the system is fragmented and the remaining native vegetation is somewhat damaged (through the impacts of urbanisation; lengthened fire regimes, bushland reserve fragmentation, increased water 0. these areas, weed invasion), the reserves still contain a diverse range of species and faunal habitats.

Stakeholders and legislative responsibilities

Willoughby City Council (WCC) is responsible for the management of approximately 300 hectares of bushland, subject to the provisions of State Environmental Planning Policy No. 19 – Bushland in Urban Areas and the Council's Urban Bushland Plan of Management, 1996, prepared in accordance with the Local Government Act, 1993. The policy and

management actions outlined in the Urban Bushland Plan of Management provide the basis for fire management works detailed here.

Fire is a natural event in bushland, though inappropriate fire regimes have the potential to impact negatively on native vegetation. The NSW Scientific Committee has identified too frequent burning as a key ecologically threatening process to native vegetation associations throughout New South Wales, and this is outlined in the Threatened Species Conservation Act, 1995. Lack of fire can also have a detrimental effect on the structure and diversity of plant species in bushland.

Council has statutory obligations to prevent the occurrence and minimise the spread of wild fires in its bushland reserves. Controlled burns are one method of achieving this. In a controlled situation fire is a valuable management tool. It is frequently used as a cost effective method to reduce fuel loads in bushland adjacent to private property – but it can also be used to facilitate the natural regeneration of native vegetation degraded by underburning, as most sclerophyll species have either vegetative or reproductive adaptations that enable them to regenerate after fire.

Controlled burns are fires purposely lit and managed so that they achieve a desired outcome. Hazard reduction fires are controlled burns used to reduce fuel loads at ground level. Ecological burns are the other form of controlled burn used to stimulate native plant regeneration and increase biodiversity. Both these types of fires are typically medium to high intensity.

The Fire Hazard Reduction Team

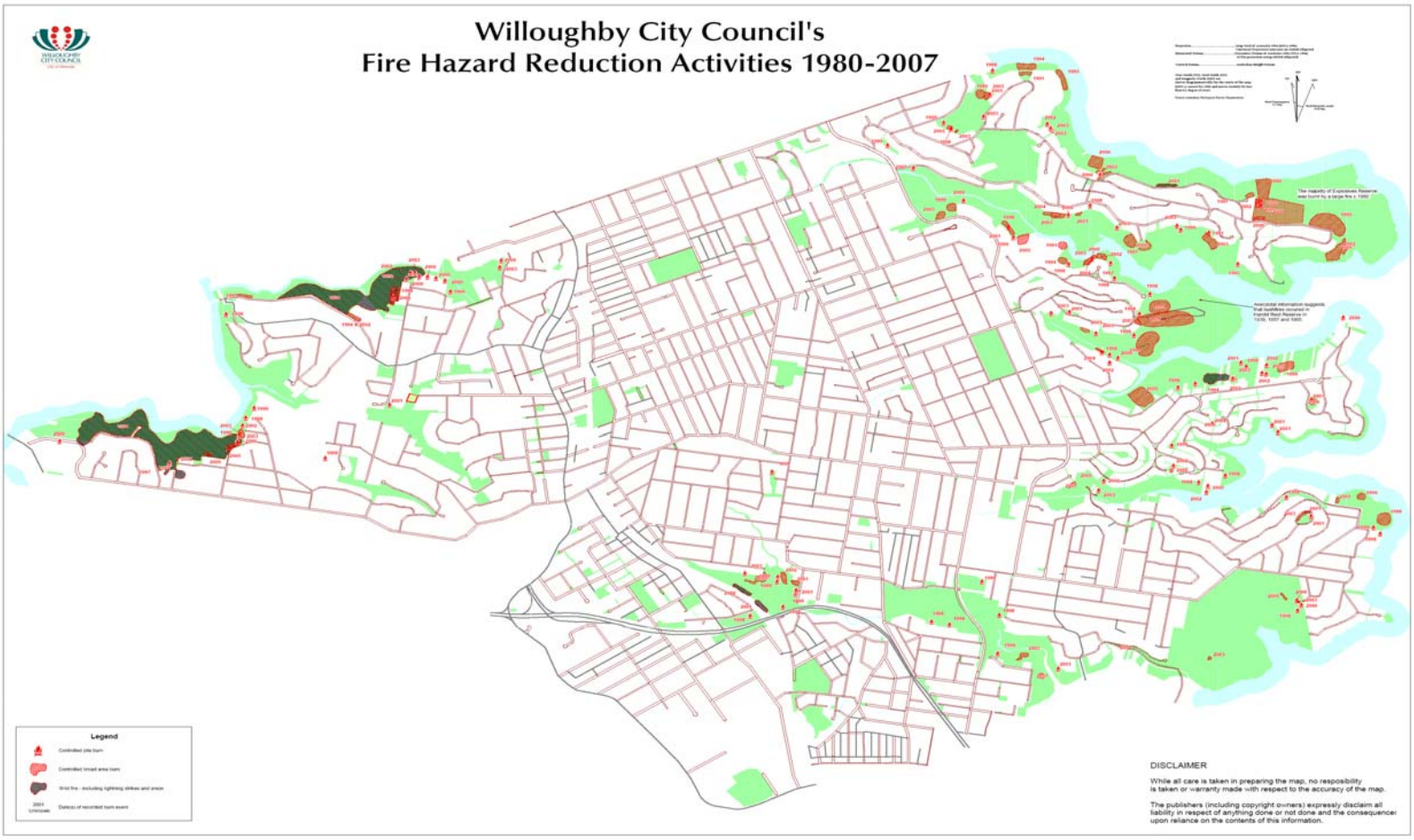
Burning may be carried out by the following agencies in Willoughby:

- Council's operational staff; and
- The New South Wales Fire Brigade

Willoughby City Council's Fire Hazard Reduction Team has been actively and effectively reducing the threat of unplanned fires through strategic burning programs since 1994 (Refer Fire History Activity Map in **figure 1** below). The Fire Hazard Reduction Team is made up of staff that hold tertiary qualifications in bushland management e.g. bush regeneration and natural resource management, which gives them unique insight into balancing hazard reduction and ecological protection. They are trained by the Rural Fire Service (RFS) and carry national qualifications in Basic and Advanced Fire Fighting.

WCC and NSWFB staff, Explosives Reserve burn May 2007

Figure 1



Ecosystem and Impacts

The use of fire offers opportunities for promoting natural regeneration of native plant species in senescing bushland, but it has some consequences to the bush that should be acknowledged, such as:

- A short-term loss of ground cover and understorey vegetation can be expected. Associated with this will be a short-term loss of fauna species dependent on those vegetation layers for food and habitat.
- The loss of the insulating qualities of leaf litter, ground covers and shrub layers will result in a temporary increase in soil temperature range and decrease in soil moisture.
- The potential for soil erosion increases temporarily until stabilised by regenerating vegetation. Should significant rainfall be experienced, the temporary discoloration of creeks may occur downstream of burnt areas.
- Smoke may affect air quality during burning operations. Environmental Protection Authority warnings will be complied with to ensure minimal pollution problems.
- If continual regular burning occurs within a period of 10 years, the loss of some species (e.g. *Banksia ericifolia*) may occur in local asset protection areas. These areas are restricted to the residential/bushland interface, providing adjoining properties in high bush fire areas with a fuel-reduced zone. In other areas burning will be

undertaken within the ecological requirements of the area and no long term decrease in species diversity is expected.

- Short-term visual and scenic qualities will be affected in areas burnt.

Restoration goals and planning

When considering a site for a controlled burn, the following aspects are taken into account:

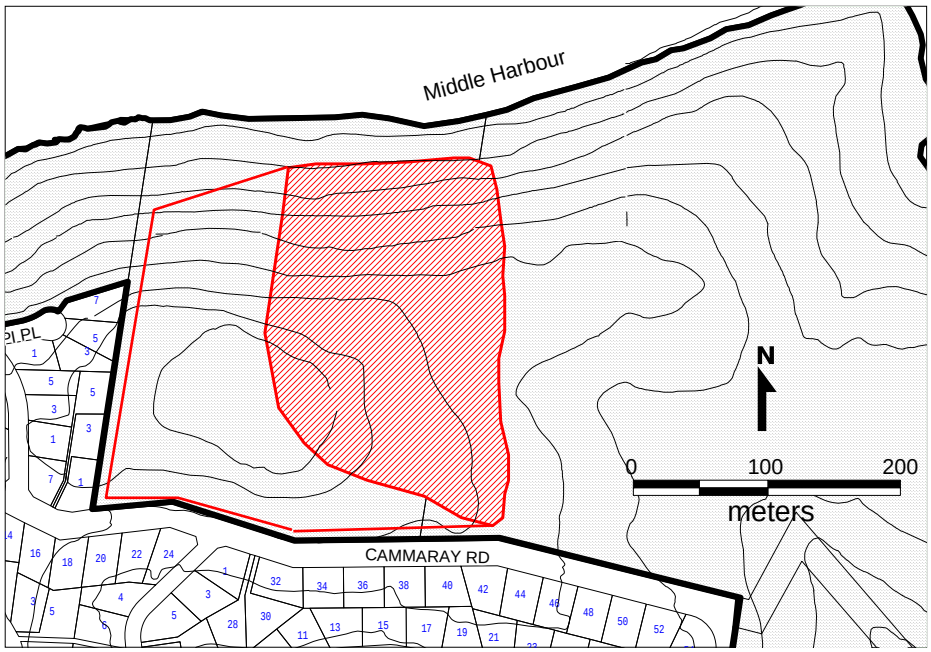
Preliminary environmental assessment:

- Management strategies
- Vegetation community
- Previous fire history
- Threatened species
- Heritage cultural assets
- Post-fire management

Ecological Burn Criteria:

- Length of time since area last burnt
- Historical record of vegetation type
- Reduced floral diversity/species decline
- Presence of dominant species – monoculture (e.g. *Allocasuarina littoralis)*
- Declining health of flora (senescing)
- Ageing communities that rely on being burned for regeneration to occur

A case study – the Explosives Bushland Reserve, Castle Cove



The Explosives reserve has a diverse range of native species typical of the Sydney Sandstone Ridgetop Woodland vegetation community with good representation in all vegetation layers. The reserve was last burnt by wildfire in 1980 but it was unclear whether the proposed site was burnt. While the surrounding areas contain a diverse range of species, the site prior to burning, was dominated by *Allocasuarina littoralis*, which indicates a previous low intensity

fire. This monoculture of *Allocasuarina littoralis* with its thick needle drop has resulted in heavy fuel levels on the ground and reduced germination of remnant seed within the soil. Emerging and sapling *Pittosporum undulatum* and *Elaeocarpus reticulatus* scattered within the midstorey indicate a mesophyll shift of vegetation through the increased time interval since fire. *Phytophthora cinnamoni*, a soil pathogen responsible for dieback has been identified within the reserve.

Description of burn area: Heath and Woodland Bushland on ridgetop
Sub Catchment: Roseville
Land tenure: Crown Land managed by W.C.C.
Aspect: North, South, East and West
No. of properties adjoining area: 5
Total area of reserve: 31.46ha
Area of works: Approx. 5 hectares
Proposed method of fuel reduction: Burning
Fire history: Wild Fire 1980
Presence of threatened species: Red-crown toadlet recorded in reserve and needs further investigation. Powerful Owl visits reserve site area, no nesting or roosting sites recorded
Presence of Aboriginal sites: One site recording, site survey to assess location and possible impacts before any fuel reduction undertaken.
Presence of Bushcare sites: None
Vegetation community: 10ar Sydney Sandstone Ridgetop Woodland
21giii Coastal Sandstone Heath
Vegetation structure: Open Forest/Woodland/Open Heath
Vegetation association: *Corymbia gummifera, Eucalyptus haemostoma, Eucalyptus sieberi*

Preliminary Assessments of the degraded state and reasons for/ to burn:

On visiting the site in early 2006 the Fire Hazard Reduction Team observed and assessed the reserve:

1. In a state of declining health (senescence).
2. There was very few ground storey species scattered throughout the burn site and the midstorey was almost entirely dominated by *Allocasuarina littoralis* (refer photos below). This change in vegetation structure from Woodland to Forest complex is a natural process of succession in the absence of fire, but this would normally be reversed with periodic fire which has more recently been excluded from the environment.
3. The eucalyptus canopy association was in extreme decline with over 70% of the mature *Eucalyptus heamastoma* trees dead. The mature *Corymbia gummifera* trees throughout the burn site were in moderate health but it was observed that there were no sapling or intermediate specimens of both these eucalypt species.
4. One team member expressed the site as a 'ghost town' with a substantial absence of bird, animal and insect activity.

It was anticipated a controlled burn within this selected site would:

- Facilitate germination of native species, in particular Fabaceae, Myrtaceae, Proteaceae, Rutaceae and Poaceae species which were missing from the mid and groundstorey layers.
- Facilitate recruitment and recovery of dominant canopy species, e.g. *Eucalyptus haemastoma* suffering effects of *Phytophthora cinnamonii*.
- Reduce *Allocasuarina littoralis* monoculture
- Reduce heavy fuel loads, including Allocasuarina needle mulch on ground
- Increase diversity and populations of sclerophyll species representative of Sydney Sandstone Ridgetop Woodland community and Coastal Sandstone Heath.
- Reduce the spread of *Pittosporum undulatum* and *Elaeocarpus reticulatus* in the vegetation community.
- Reduce weed invasion – It is expected that once the burn is completed there will be a number of invasive weeds spreading into the open fertile soils of the burn area from the presently effected area adjacent to the burn on the road edge. The types of weeds present on the road edge adjacent to this bushland reserve are those with windblown seeds e.g. fleabane and some other annual

grasses. There has been a scarcity of weeds within the burn area itself. Council staff regularly weeds this road edge and the weed numbers and species are in decline.

Pre-fire species list:

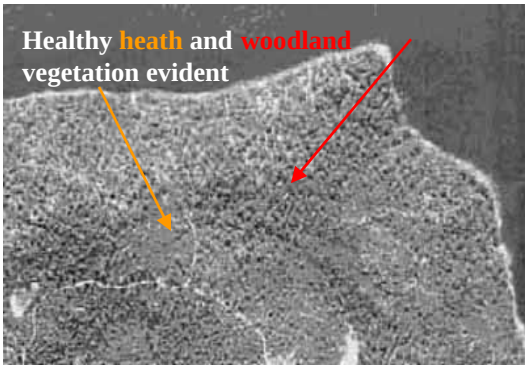
FAMILY	GENUS	SPECIES
ADIANTACEAE	*Adiantum*	*aethiopicum*
DENNSTAEDTIACEAE	*Pteridium*	*esculentum*
DICKSONIACEAE	*Calochlaena*	*dubia*
LINDSAEACEAE	*Lindsaea*	*linearis*
APIACEAE	*Actinotus*	*minor*
APIACEAE	*Platysace*	*linearifolia*
CASUARINACEAE	*Allocasuarina*	*littoralis*
CYPERACEAE	*Caustis*	*reolute*
ELAEOCARPACEAE	*Elaeocarpus*	*reticulatus*
EPACRIDACEAE	*Styphelia*	*longiflora*
EUPHORBIACEAE	*Glochidion*	*ferdinandii*
EUPHORBIACEAE	*Micrantheum*	*ericoidesi*
FABACEAE	*Pultenea*	*elliptica*
FABACEAE	*Acacia*	*suaveolans*
FABACEAE	*Pultenea*	*flexilis*
LILIACEAE	*Dianella*	*caerulea var. producta*
LOMANDRACEAE	*Lomandra*	*glauca*
LOMANDRACEAE	*Lomandra*	*longifolia*
LOMANDRACEAE	*Lomandra*	*oblique*
MYRTACEAE	*Angophora*	*costata*
MYRTACEAE	*Angophora*	*hispida*
MYRTACEAE	*Corymbia*	*gummifera*
MYRTACEAE	*Eucalyptus*	*haemastoma*
MYRTACEAE	*Eucalyptus*	*sieberi*
MYRTACEAE	*Leptospermum*	*squarrosum*
PITTOSPORACEAE	*Pittosporum*	*revolutum*
PITTOSPORACEAE	*Pittosporum*	*undulatum*
POACEAE	*Entolasia*	*stricta*
POACEAE	*Imperata*	*cylindrica*
POACEAE	*Oplismenus*	*aemulus*
PROTEACEAE	*Banksia*	*ericifolia*
PROTEACEAE	*Hakea*	*sericea*
PROTEACEAE	*Lomatia*	*silaifolia*
PROTEACEAE	*Persoonia*	*levis*
RUTACEAE	*Crowea*	*saligna*
SAPINDACEAE	*Dodonea*	*triquetra*
SMILACACEAE	*Smilax*	*glycophylla*
XANTHORRHOEACEAE	*Xanthorrhoea*	*arborea*

(Refer to **Post-fire** species list for comparison in 'How the site responded to the burn and follow up weed control' section)

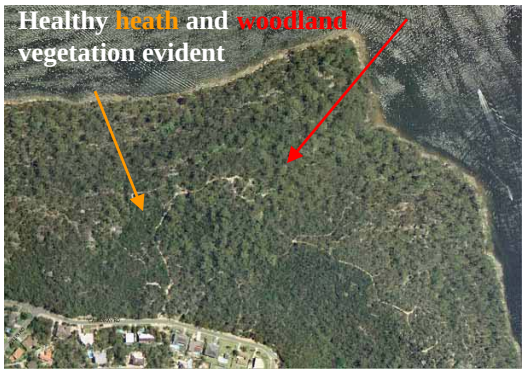
Proposed burn site showing heavy mulch of Allocasuarina needles, Allocasuarina dominance (monoculture) of site and lack of native species diversity and numbers in the midstorey and groundstorey layers

Historical records of Vegetation

Explosives Reserve – 1943



Explosives Reserve – 1978

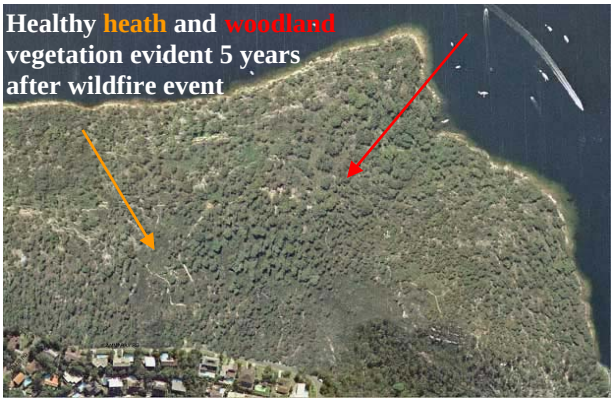


Explosives Reserve wildfire - 1980

The aerials photos above and below illustrate the structural change in the vegetation of this reserve over a period of 60 years. From 1943 to 1978 some interesting changes have taken place; firstly the estate of Castle Cove has been opened up to housing development; secondly the canopy and vegetation structure has grown and thickened. There is no recorded fire event in these 35 years. Two years later in 1980 a wildfire event occurred but it was not recorded what percentage of the reserve was burnt. In the 1985 aerial photo (5 years after wildfire) there is a healthy open

canopy characteristic of the vegetation complex that is expected for this Sydney Sandstone community. The vegetation association has been classified and documented as 'Sydney Sandstone Ridgetop Woodland' and 'Coastal Sandstone Heath' (refer legend and map below photos). By 2005, 20 years on, the canopy and midstorey of the reserve has become closed, predominately dominated by two native species *Allocasuarina littoralis* and *Pittosporum undulatum*. With the rapid fragmentation of this reserve, caused by the considerable rise in urbanisation there is a number of other significant impacts that may have assisted in an increased change to the vegetation structure, e.g. elevated levels of water runoff into the reserve.

Explosives Reserve - 1985



Explosives Reserve - 2005

Vegetation community Associations in Explosives reserve

Project implementation

Once this ecological burn site had been chosen the area was measured and marked out. Drainage lines were located and the proposed burn area boundary lines were kept clear from these due to erosion potential. If, for example a site is on a steep slope above a waterway the lower boundary is located above the waterline/foreshore to avoid erosion. A Review of Environmental Factors (REF) was carried out to assess the burns impacts on Cultural, Aboriginal, Vegetation, Fauna, Water, Air, Scenic and Historical values in the site. Dry and dead vegetation fuel standing, was cut down and incorporated into the burn. The Fire Hazard Reduction Team also cut down the two dominant (fire sensitive) native species (*Allocasuarina littoralis* and *Pittosporum undulatum*) down and placed the debris in areas that require more fuel to ensure heat penetration into the organic layers. (This 'green' material was allowed to season and dry out for a period of approximately 3 months to reduce smoke pollution levels). This was also done to facilitate the prevention of canopy fires caused by 'ladder fuels'. This treatment was also designed to produce a hotter burn to replicate a

wildfire event similar to that to which these sclerophyll native plant species are adapted. A pre-burn species list was prepared of the flora and fauna. Close to the date of the proposed burn the fire lines were cut and neighbouring residents and local Fire Brigades were notified. The Fire Hazard Reduction Team, where possible used formed bush tracks and geographical features such as rock outcrops as fire lines to reduce and alleviate workloads and avoid disturbance of the soil before the burn, which reduces the occurrence of native germination if the burn is postponed for a lengthy period.

On the day of a proposed burn an assessment was made of the ground fuel for moisture content before the burn proceeded. A burn is called off and postponed if there is a Total Fire Ban or when the Environment Protection Agency (EPA) declares a No Burn Day due to air pollution concerns. Before a burn is undertaken trees are searched for possum drays and attempts are made to remove any possums found. The lighting patterns are strategically planned to provide corridors for wildlife to escape. A Wildlife Rescue (W.I.R.E.S.) representative is invited to participate in site inspection and to assist with injured animals.

Summary of Explosives Reserve burn day activity

Weather:

- Mild Temperature 24°C
- North westerly winds
- 52% relative humidity

Fire:

- Personnel included 12 WCC and 25 NSWFB staff including 4 fire-fighting appliances (NSWFB trucks known as 'pumpers') from the metropolitan area.
- Started at 10.50am
- Fire was lit on ridge and crept down the North facing slope followed by the same lighting method for the Southern slope
- Flame height of a couple of metres after 10 minutes.
- Flame height was 2m to 2.5m throughout the site during the fire.
- Flames had died down in 3 hours.
- The Council Team stayed with the burn till 9.30p.m.


Explosives Reserve burn site on morning of burn day, 29/05/2007


Smoke rising from Explosives Reserve burn

The Explosives Reserve burn in full swing, May 2007

A WCC staff member lighting up

A NSWFB Natural Hazards Senior Officer, being interviewed for WCC's dvd.

Burn site prepared, note midstorey open from removal of *Allocasuarina littoralis*

Burn site 1 day after burn

Burn site 1 month after burn, note leaf drop

Ecological outcomes in the Explosives Reserve case study burn area:

Flannel flowers (*Actinotus helianthi)* in burn site, 1 year on

A diverse emergent native shrub layer, 1 year on

Actinotus minor and native grasses, 1 year on

Vellia lyrata, in burn area, 1 year on

Banksia ericifolia seedling in burn area

Dylwinia retorta seedlings in burn area

Blandfordia nobilis and *Lomatia siliafolia* in burn area

Presentation of flannel flowers (*Actinotus helianthi)* on mass in burn, 1 year after burn

Post Fire Management:

As the loss of ground cover and understorey vegetation may favour the establishment or expansion of some exotic weed species into some areas. Council undertook weed control in the post fire period in accordance with the Urban Bushland Plan of Management, 1997.

In addition, the fire team's plan for post-fire management of this burn area included:

- Using weeds as 'nursery' plants (cutting seeds and flowers off but leaving foliage to shade native seedlings in hotter months)
- Cutting weeds at the base of plant rather than pulling out to prevent the disturbance of emerging native seedlings
- Understanding weed seeding times ('target weed' weeds in seed or flower – allows team to move through the site quickly rather than getting bogged down in one area)
- Strong focus on increased regularity of site visits for first 9 months after burn.
- The post-fire management in this particular site includes the removal of *Allocasuarina littoralis* seedlings that have regenerated in substantial numbers.

How the site responded to the burn and follow up weed control

A species list was taken 17 months after the burn was completed (see post-fire species list below) and was compared with the species list taken prior to the fire and the results indicated there was a dramatic increase in native plant species diversity - particularly those species absent from the midstorey layers prior to the burn. This post-fire species list illustrated; the types of native plant species that require fire for regeneration and the longevity of seed survival of native plant species that had not been recorded in the reserve system for 20+ years.

The post-fire list of native species (below) were absent from the recorded pre-fire species list prior to burning.

Post-fire species list to date (1 year after burn):

FAMILY	GENUS	SPECIES
APIACEAE	*Actinotus*	*helianthi*
CASUARINACEAE	*Allocasuarina*	*distya*
COHIACEAE	*Burchardia*	*umbellata*
DILLENIACEAE	*Hibbertia*	*dentata*
EPACRIDACEAE	*Epacris*	*longiflora*
EPACRIDACEAE	*Epacris*	*mycrophylla*
EPACRIDACEAE	*Woolsia*	*pungens*
FABACEAE	*Acacia*	*terminalis*
FABACEAE	*Acacia*	*ulicifolia*
FABACEAE	*Dilwynia*	*retorta*
FABACEAE	*Pultenea*	*daphnoides*
FABACEAE	*Pultenea*	*stipularis*
GOODENIACEAE	*Dampiera*	*sticta*
GOODENIACEAE	*Goodenia*	*heterophylla*
GOODENIACEAE	*Vellia*	*lyrata*
HALORAGACEAE	*Gonocarpus*	*teucrioides*
IRIDACEAE	*Patersonia*	*glabrata*
LILIACEAE	*Blandfordia*	*nobilis*
LOBELIACEAE	*Lobelia*	*gracillis*
MYRTACEAE	*Kunzea*	*ambigua*
PAPILIONACEAE	*Hovea*	*purpurea*

PITTOSPORACEAE	*Billardiera*	*scandens*
POACEAE	*Echinopogon*	*caespitosus*
POACEAE	*Microlaena*	*stipoides*
POACEAE	*Themeda*	*australis*
POLYGALACEAE	*Comesperma*	*ericinum*
PROTEACEAE	*Grevillea*	*buxifolia*
PROTEACEAE	*Grevillea*	*linearifolia*
PROTEACEAE	*Grevillea*	*speciosa*
RHAMNACEAE	*Pomaderis*	*lanigera*
RUBIACEAE	*Pomax*	*umbellata*
RUTACEAE	*Boronia*	*rosmarinifolia*
RUTACEAE	*Philotheca*	*salsolifolia*
RUTACEAE	*Zieria*	*smithii*
STERCULIACEAE	*Laseopetalum*	*macrophyllum*
THYMELAEACEAE	*Pimelea*	*Linifolia spp. linifolia*
TREMANDRACEAE	*Tetratheca*	*ericifolia*

The team also set up 3 monitoring transects (20 metres long by 2 metres wide) after the burn throughout the Explosives Reserve burn site (1 on the south side, 1 on the ridge top, 1 on the north side) to identify flora diversity and density (including ground, mid and canopy species) as well as evidence of fauna e.g. sightings, scats, marks, diggings, and fur/ hair. Data from these transects will act as baseline data to guide ongoing management and future fires.

Weed control

The Council Fire Hazard Reduction team assesses for and carries out weed control works on a monthly basis. So far there have only been a small number of annual grasses invading the area from an area adjacent to the road edge, particularly the weed grass *ehrharta erecta*.
The team is also reducing the number of *Allocasuarina littoralis* seedlings throughout the burn particularly on the exposed ridgetop areas where you would not expect these plants to inhabit naturally.

Progress with the overall program to date

Willoughby City Council's Hazard Reduction Team has had a high level of success with dual hazard reduction and ecological burns throughout the LGA in sites selected by the assessment methods carried out in this case study. In all burn areas it has been recorded (photos and pre/ post fire species lists) that there has been an increase in species diversity and density within the burnt sites. The Fire team is constantly comparing results of each burn with data collected on previous burns to determine, a) methods of current work practices (assessment and preparation effectiveness) b) Preferred outcomes (ecological and fuel reduced – balance achieved) and c) what worked and how we can improve these work systems.

There has been positive feedback from residents throughout the Willoughby LGA about Council's burns. One example of this is that long time residents adjoining Explosives Reserve had not seen Christmas Bells (*Blandfordia nobilis*) for a long period of time and were very happy to see them again.

Monitoring and research links

Willoughby City Council's Fire Hazard Reduction Team monitors the ecological outcomes through:

1. Comparison of Pre- and Post-fire species lists

2. Before and after photos of a burn site every couple of months (for ongoing comparison)
3. Fauna sightings and evidence of animal activity in burn area are recorded and entered into a central database. The photos below illustrate some of the exciting sightings to date.


Swamp wallaby on edge of burn area


Yellow tailed black cockatoo in burn area


Echidnas have been spotted in burn area

4. Willoughby has hosted two ecological burn workshops in collaboration with the Nature Conservation Council (NCC) in 2007 and 2008 with healthy representation from local/regional Council's, NCC representatives, the NSWFB and the RFS.


Philip Sarkies (Team Leader of the Fire Hazard Reduction Crew) outlines WCC's work methods at the WCC and NCC ecological fire workshop, Sept 2008)

5. Willoughby City Council has established a strong equitable working relationship with the New South Wales Fire Brigades (NSWFB) in regards to achieving ecological outcomes as well as fire mitigation practices.
6. Willoughby City Council has produced a brochure on *Criteria for Ecological burns* and created a DVD titled *Bushfire Management and Fire Ecology in Willoughby* primarily used for the training of council staff about the Fire Hazard Reduction Teams activities.

Lessons learned

By combining the management objectives of Hazard Reduction and Ecological principles we can satisfy the legislative obligations of property protection and the conservation needs of native vegetation that rely on fire for survival. Post-fire species lists are indicating the longevity of the native seed banks despite many years of degradation in some cases. This is helping us to comprehend the life cycle adaptations/ mechanisms of these plants to survive in long unburnt urban areas and potential thresholds beyond which recovery may not occur. The team continually evaluates and reviews work methods in line with previous work activities. Burning of our larger (1 hectare and above) areas are planned ideally in between

seasons to reduce loss of animal species e.g. not burning in spring when animals have young and not during the winter when reptiles are lethargic and insects are in the pupal stage of their life cycles. Burning in between seasons also reduces the loss of native seedlings particularly through the hot summer months. We are constantly learning that fragmented and apparently degraded urban bushland areas are indeed resilient and of intrinsic ecological value. This information is now being recorded more effectively that indicates an overall picture of the need to intervene with the use of fire for ecological restoration as well as for hazard reduction

Acknowledgements:

- Willoughby City Council Fire Hazard Reduction Team
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- New South Wales Fire Brigades

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