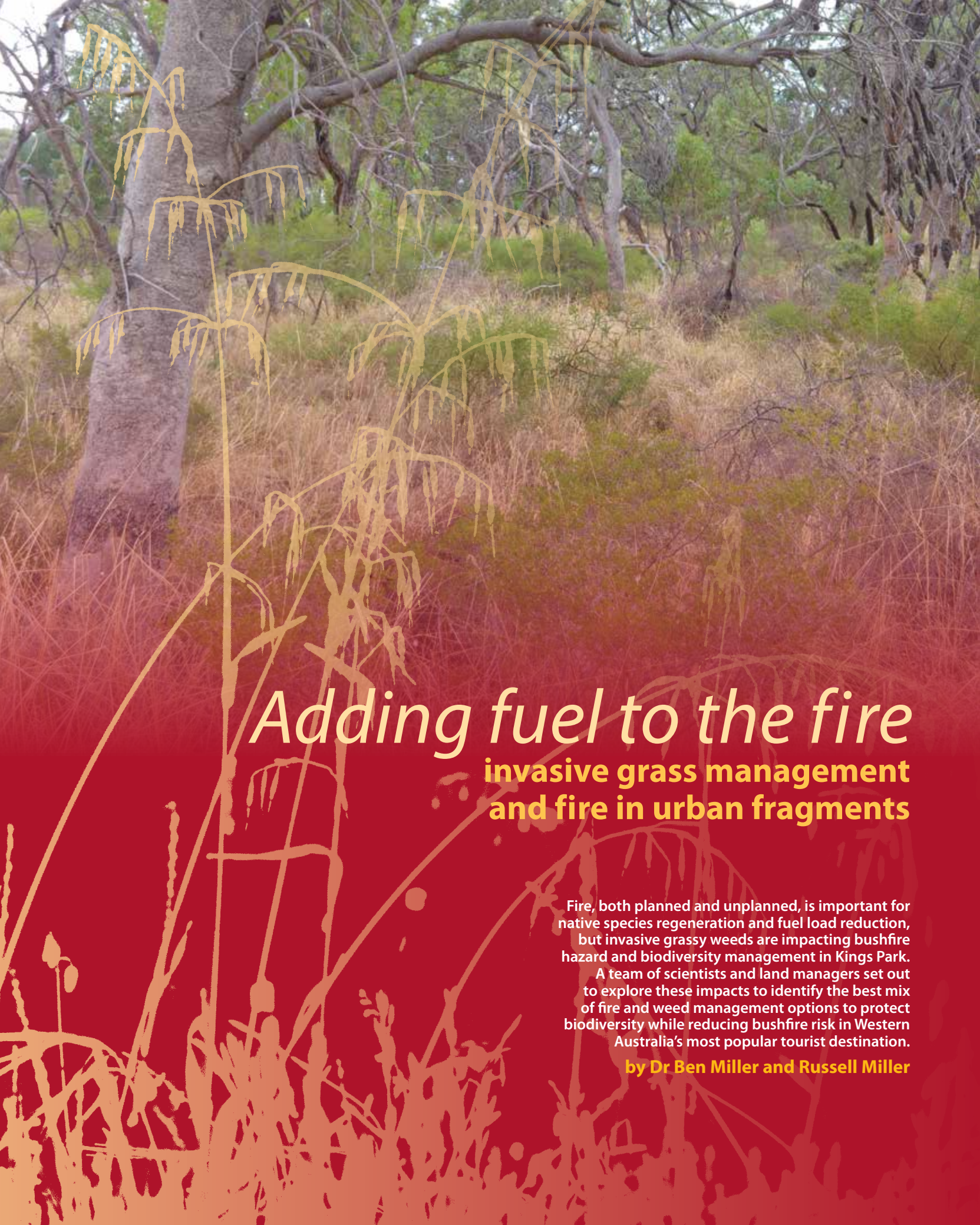

Adding fuel to the fire

invasive grass management and fire in urban fragments

Fire, both planned and unplanned, is important for native species regeneration and fuel load reduction, but invasive grassy weeds are impacting bushfire hazard and biodiversity management in Kings Park. A team of scientists and land managers set out to explore these impacts to identify the best mix of fire and weed management options to protect biodiversity while reducing bushfire risk in Western Australia's most popular tourist destination.

by Dr Ben Miller and Russell Miller

Like many terrestrial ecosystems around Australia, Perth's urban banksia woodlands are fire-prone. For land managers, including Kings Park's Botanic Gardens and Parks Authority (BGPA), managing fire risk in urban and urban fringe bushlands is a critical concern, and the presence of some invasive grassy weeds substantially adds to the challenge.

Scientists from DBCA's Biodiversity and Conservation Science have been collaborating with land and fire managers from the Parks and Wildlife Service's Swan Coastal District, BGPA, the Department of Fire and Emergency Services (DFES) and local councils, to understand the positive and negative effects of prescribed burning in urban bushlands where the spread of grassy weeds is an unwanted fire hazard and conservation threat.

GRASS-FIRE CYCLE

In 1927, John Heath, the Kings Park superintendent, noted the ability of perennial veldt grass (*Ehrharta calycina*), accidently introduced from South Africa, to grow densely in banksia woodland understory. At the same time, he also noted an increasing problem with bushfires in the park. The problem he identified is one we know today as the 'grass-fire cycle': the pattern of grass invasion promoting the spread of fire, and fire promoting the spread of grasses (see 'The grass-fire cycle' below).

About 75 species of native grasses occur in the wetter half of south-west Australia, but the ecosystems that they dominate, such as coastal dunes, are few and restricted. Where native grasses occur in south-west forests and woodlands, they contribute little to fuel structure and fire spread, however, this

The grass-fire cycle

Grass invasion into woody vegetation increases the abundance of fine fuels which can increase fire frequency and fire spread. Many native woody species cope poorly with frequent fire but grasses can readily resprout after fire and the recruitment of new individuals is often enhanced, facilitating further grass invasion and dominance, which in turn promotes more fire and a self-perpetuating cycle.

Previous page
Main Grassy-weed-invaded urban banksia woodland.
Photo – Russell Miller/DBCA
Inset Annual grassy weeds in silhouette.
Photo – Sallyanne Cousans

Above left Typical banksia woodland with no grassy weeds present.

Above Curing grasses filling gaps 18 months after fire at the Kings Park experimental burn site in the non-weed managed treatment.
Photos – Russell Miller/DBCA

situation changes when introduced grasses invade these systems.

Many European and South African grass species that have been introduced into Western Australia since European colonisation have become established as weeds in native vegetation. Now, we have more non-native than native grass species in the south-west of WA. Introduced annuals, such as annual veldt grass (*Ehrharta brevifolia*, *E. longiflora*), wild oats (*Avena* spp.), several *Aira* and *Briza* species may be very abundant in disturbed bushlands but are more transient in their impact. Perennial veldt grass (*Ehrharta calycina*) and African love grass (*Eragrostis curvula*) are among the most notorious bushland invaders, with a long-term presence and impact.

Grass invasion into woody vegetation increases the abundance of fine fuels which ignite and flame quickly when dry. Grasses also dry (or 'cure') rapidly, making them available to burn earlier in the day or in conditions when woody fuels may not ignite. Grasses also grow quickly, creating new fuel even after a recent fire, and can develop in dense or continuous arrangements so that, under the right conditions, they can promote the rapid spread of fire. Where fuels are dominated by grasses, bushfires are usually faster moving, and more frequent but lower intensity than in ecosystems where material from woody plants dominate.

In turn, more frequent fire enhances the spread of perennial veldt grass and other invasive grasses by promoting seed germination and seedling establishment. Many grasses can also resprout after fire and all take advantage of the soil nutrient pulse that occurs. Capturing nutrients released by fire, these weeds build their competitive capacity by reducing the nutrient pool available to native plant regeneration.

The distinction between dominant fuel types, and therefore fire regimes, may also filter the species that can persist. For example, many woody species in Mediterranean-climate forests, woodlands and shrublands of south-west WA rely on seedling regeneration to recover after fire and ensure long-term persistence, but seedlings may be sensitive to fire, and may take several years to mature and produce seeds. Such species may not be able to persist in ecosystems with grass dominated fuels that burn frequently.

THE EXPERIMENTS

Not only are invasive grassy weeds a fire hazard, they also negatively impact native species in many ways. Weed, fire and biodiversity management activities can have a direct positive or negative impact on this situation.

With help from Kings Park bushland managers, scientists commenced a series of experiments examining the effects of different prescribed burning rotations,

"Capturing nutrients released by fire, these weeds build their competitive capacity by reducing the nutrient pool available to native plant regeneration."

Above left The experimental burn at Bold Park, strongly weed invaded in the foreground.

Top *Banksia attenuata* seedling emerging after fire in banksia woodlands.

Above Red and green kangaroo paws (*Anigozanthos manglesii*) flowering in the weed-managed treatment after fire in Kings Park.
Photos – Russell Miller/DBCA

Top Bold Park burn site 18 months after fire. Note weed control treatment on left of image where native species dominate, compared to non-weed control-treatment on right of image where grassy weeds dominate.
Photo – Ben Miller/DBCA

Above BGPA Bushlands staff assisting with survey of plots one year after burning in Bold Park.
Photo – Russell Miller/DBCA

together with weed management, on native plant diversity and grassy weeds in urban bushlands.

The first experiment took place in Kings Park where, in six treatment blocks, native plant species abundance, fuel structure and weed cover were surveyed. Then, in May 2015, with staff and fire crews from DBCA's Swan Coastal District and several DFES brigades, a six-hectare experimental fire was implemented across four of the six treatment blocks, leaving two unburnt controls.

Bushland managers then implemented their standard grass and bulbous weed management regimes in two of the burnt blocks and one of the control blocks. Native species abundance, fuel structure and weed cover were remeasured in the subsequent years, with a plan to burn the area again in a 12- to 16-year rotation. It is also proposed to burn two of the blocks at half that time, so that the area would have unburnt, long, and short interval treatments, crossed with the presence and absence of weed management.

This experiment was followed up with a second site in Bold Park burnt in 2016. In partnership with the City of Canning, City of Cockburn, and City of Greater Geraldton, three more sites have since been added to the experimental network.

THE RESULTS

Now, after five years, results from Bold Park and Kings Park experiments are coming in, and plans are underway for the next burn. Results show that fire indeed does enhance the spread and cover of introduced grasses, that weed management treatments are effective in reducing weed cover, and that burning leads to a decrease in litter fuels.

The experiment also confirmed the previous understanding that fire encourages the regeneration of native species. Many seedlings of native perennial species established post-fire, and several species that were not observed in pre-fire surveys emerged from seedbanks.

One benefit of replicating the experiment across multiple sites is that we can observe how sites with different starting conditions might respond to fire and weed management. The site chosen in Bold Park had high pre-fire weed cover, whereas the site in Kings Park had relatively low pre-fire weed cover.

In Kings Park, fire alone led to a tripling of introduced grass abundance (mostly perennial veldt grass) and increased grass fuel connectivity, and possibly the increase of fire hazard. However, fire plus weed management kept grasses at or below their previous levels.

After burning, native species recovery was greatest in sites receiving weed control, suggesting that competition from weeds after fire may depress native species regeneration. The herbicides used are specific to grasses or were targeted to bulbous weeds. If there was an off-target impact of these herbicides, it would have been more than offset by the effect of reduced weed competition.

In Bold Park, in the absence of a control, weed regeneration was so strong that native species abundance declined after fire, but it more than doubled when weeds were managed. Fuel continuity attributed to grass cover dropped in the year after fire, but, if unmanaged, returned to the same high levels in the following years. When weed management was applied, fuel continuity dropped to very low levels.

While the long-term study is still in the early stages and there are other sites to analyse, initial results highlight the fire hazard posed by grassy weeds in urban bushlands, and the role of fire in enhancing the problem. As these weeds suppress native species recovery, burning without weed management in urban reserves and at the edges of fragmented remnants may lead to increased hazard and degradation of ecological values. Weed management can help reduce one element of fire hazard in grass invaded bushlands, but an appropriate fire regime plus weed management can further reduce hazard, and enhance regeneration of degraded systems.

Top *Anthocercis ilicifolia,* a fire ephemeral usually observed for only for a few years after fire (here flowering in Kings Park).

Above BGPA Bushlands staff applying weed management treatments at the Bold Park experimental site.
Photos – Ben Miller/DBCA

Above right Recovery after a summer wildfire in banksia woodland.

Right Red and green kangaroo paws flowering in Kings Park, unburned control treatment.
Photos – Russell Miller/DBCA

Dr Ben Miller is a DBCA Biodiversity and Conservation Science Fire Science program leader and can be contacted at ben.miller@dbca.wa.gov.au

Russell Miller is a DBCA Biodiversity and Conservation Science research scientist and can be contacted at russell.miller@dbca.wa.gov.au