The Critical Coexistence of Risk Mitigation and Vegetation Restoration

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Introduction

Prescribed burning as a bushfire fuel management tool has been used by Australian Aboriginal people for thousands of years. European's first witnessed and documented introduced fire in the landscape on Australia's east coast on 28th May 1788 at Sydney's North Head (Clark and McLoughlin, 2009; Hunter, Capt. J, 2009). Since that time introducing fire in the landscape has posed many challenges for land management agencies and Firefighting Authorities.

Eastern Australia is one of the most bushfire prone locations in the world with many of its vegetation formations fire dependent. Coastal heathlands dominated by hard-leaved shrubs growing on infertile sandy soils, often in exposed areas, are one of many such vegetation types. Containing numerous species that are obligate seeders relying on their soil seedbank to regenerate after fire, these heathlands include plant communities that are at risk of extinction as a result of human pressures, which include inappropriate fire intervals. One such vegetation community is Eastern Suburbs Banksia Scrub (ESBS).

Managing the risk of bushfire in a peri-urban and urban environment requires rigorous management of the bushland vegetation structures. The use of prescribed fire to reduce fuel loads is an important bushfire risk mitigation tool. In recent decades, scientists have increasingly recognised that managed prescribed fire can assist not only in protecting life and property, but also as a restoration tool to ensure the health of a thriving remnant ecosystem is maintained. Given the importance of bushland waterfront vistas to international recognition of Sydney and its Harbour, maintenance of these bushland areas is important in providing social capital to the city and enhances its natural, economic, and social environments.

In 2004, the NSW Department of Environment and Conservation acknowledged that, at the plant community level, the fire ecology of ESBS is not well understood, but observed that periods of 15 years or more without fire or similar disturbance simplify the structure and floristic composition of ESBS to a point where the standing vegetation is dominated by a few species. They recommended that successive fire intervals of less than 8 years or more than 15 years and fire exclusion for more than 30 years should be avoided. While these estimates of optimal fire frequency are generally accepted and practiced, the impacts of fire intensity on ESBS are less specifically understood. In a review of the status of ESBS in 2016, the NSW Threatened Species Scientific Committee (2017) determined that "the distribution of Eastern Suburbs Banksia Scrub has been transformed from extensive areas associated with sand sheets to small fragments ranging in size from 0.02 to 69 ha". Consequently, the Scientific Committee determined that ESBS be upgraded to Critically Endangered status.

Recent prescribed burns are providing an opportunity to further explore the ecological parameters of fire in ESBS restoration.

Materials and Methods

Since early in the current decade Fire and Rescue New South Wales has been working with various land managers in coastal Sydney to re-introduce managed fire as a tool to restore ESBS.

La Perouse

Windrow burning has been used on remnant ESBS (total area 12.96ha, Perkins et al. 2012) occupying land between the fairways and Headland at the NSW Golf Course in La Perouse, where the dominant species, Coastal Tea-tree (*Leptospermum laevigatum*) was cut and dropped on the ground and allowed to cure. Isolated pockets were then burnt at high intensity. Burning on a golf course is a lot easier than North Head because there are far fewer risks requiring managed mitigation, and knowing the eastern boundary is the Pacific Ocean assists. With this type of environment and preparation we can get extremely high intensity burns which appear beneficial for ESBS. The land managers fenced the area to stop exposure to rabbits and other herbivores. An arson in the same fire season provided an additional 21 hectares of wildfire (unplanned fire). Measures were put in place to monitor what introduced fire has done compared with what wildfire (unplanned fire) has done in the same vegetative area.

Centennial Park, Randwick

Centennial Park, in the middle of Sydney, has an area of ESBS of less than a hectare. The Park's owners, the Centennial Park Trust, have been manually clearing weed from the ESBS area and undertaking selective thinning, piling it and then conducting pile burns on the area, then spreading the ash from that. Once again, some positive and diverse regeneration has occurred assisted by the burn area also being fenced off to stop rabbits and other herbivores.

North Head at Manly

Major botanical studies have been undertaken in the lead-up to, and at intervals following, carefully planned fuel reduction burns at North Head, Manly, where the largest relatively intact remnants of ESBS are found. The remainder of this paper will focus on the logistics and results of these fires.

<u>Fire logistics and operational planning</u>

In September 2012, three burns were conducted: Third Quarantine Cemetery (0.8 ha), North Fort (1.5 ha) and Bluefish Drive (1.8 ha - not ESBS). The whole of North Head is not only home to the largest remnants of ESBS (approximately 69 ha in total, some intact and some disturbed), but it is also a National Heritage site, with significant built and cultural heritage features situated close to the perimeters of the densely settled tourist destination, Manly. A methane generator unit is also located at the Wastewater Treatment Plant adjoining the site. Consequently, these burns involved very high levels of logistical and operational planning, prior to waiting for the appropriate burn conditions.

a) Public safety. Because of a history of fires getting out of control at North Head, precautions involved restricting public access to the headland, which meant confining all three burns to one day to minimise disruption. There was an overall incident controller for the North Head complex, plus divisional commanders in charge of each of the burns. The divisional commanders essentially were running their individual burns managing their operations officers and resources required. Thirty-six firefighting resources were contributed by three agencies: Fire and Rescue New South Wales, National Parks and Wildlife Service and Rural

Fire Service (Northern Beaches). In total 121 fire fighters were deployed for these small sites. State Emergency Service assisted us with closing walking trails and making sure people were not accessing the headland.

b) On the day of the burns there were 400 children attending school and pre-school activities on the headland. This required completion of the steps in the local emergency management plan and arrangements with Sydney Ferries to make sure there was a ferry ready and available in case there was a need to evacuate the headland by water. Harbour Control was also notified in case the fire got away and it became necessary to shut down the shipping channels coming into Sydney Harbour.
c) Heritage protection. We obtained mitigation funding through the National Disaster Resilience Funds to do mitigation clearing. This involved some clearing along those walls to protect the historical significance of to protect historic stone walls that crisscross the headland. This clearing doubled to create a strategic fire advantage zone over the headland.
d) Miscellaneous risks. Among the other challenges were:
    - the need to cover and insulate air intakes to underground ventilation of historical war tunnels throughout North Head, done to prevent smoke increasing the Carbon Monoxide levels
    - a carry-over from past Defence use of the site was possible unexploded ordinance on the headland
    - the Sydney Water treatment plant opposite the Bluefish Drive burn involves an above-ground storage tank of highly explosive biogas.
e) For ecological reasons, the burns could only be done in certain seasons. The breeding seasons of the Endangered Populations of Long-nosed Bandicoots and Little Penguins on the headland had to be considered. This also involved working in with University of New South Wales studies of pre- and post-fire introduction of the bandicoot population.

A notification strategy had to be put in place for residents, tenants and other key stakeholders in the site. The weather window, given all the other constraints, was very narrow. An email notification system gave people 24 to 48 hours' notice prior to actually going ahead with the burn.

Together, these high-level risks meant the confidence of senior management of Fire and Rescue NSW was required to support the burn. That support, as well as support from all the other land managers, was very strong.

In terms of the burns operations themselves, once fire was introduced to the burn area it developed very good intensity. It was very high fuel load situation and one interesting challenge was to stop the fire fighters from putting the fires out prematurely as buildings were quite close to the treatment areas plus they were small parcels to burns.

<u>Ecological methods</u>

In 2012-13 the North Head Sanctuary Foundation (NHSF), in partnership with the Australian Wildlife Conservancy (AWC), conducted a study on two treatments, the use of fire, and selective thinning, as tools for the restoration of degraded ESBS at North Head, Sydney.

The two ESBS sites scheduled for hazard reduction (Third cemetery and North Fort) were surveyed pre-burn for their floristic attributes. Prior to the burns, a total of 37 7x7 metre quadrats were allocated by a randomisation process across burn sites (31 quadrats) and thinning sites (5

quadrats). Within the central 5 x 5 metre core of each quadrat, four 1 x 1 metre plots were selected randomly and permanently tagged.

Surveys were carried out in all quadrats, one third of which were fenced in the immediate post-fire period to assess predation by rabbits and other herbivores. Similar quadrats were established on adjoining unburnt sites from which dominant species (*Leptospermum laevigatum* and *Monotoca elliptica*) were selectively removed using chainsaws, with as little other disturbance to the site. This process sought to approximate vegetation removal consistent with alternative fire risk management practices. Removal of the dominant species resulted in a nearly 100% opening of the previous canopy, with only a few low-growing species and *Leptospermum* seedlings remaining. The wire mesh and star-picket fence designed to exclude herbivores included a pegged skirt to deter burrowing.

Quadrat surveys were carried out prior to the burn and at six, 12 and 36 months post-treatment to record the following attributes:

- species identification;
- species count;
- classification as “Native” or “Weed”;
- developmental stage (seedling, juvenile, mature);
- reproductive status when observed (flowering, seeding, etc.); and
- height in centimetres

These expert botanical surveys were complemented by a less detailed survey at 60 months post-fire.

In May 2018 a further prescribed burn was conducted over a 4.58 ha area on North Head. While the methods used were largely those used in the 2012 burn study, the latter burn was over a larger area, with pre-fire fuel management, herbivore exclusion fencing layout, post-fire rainfall events, air temperatures and timing of post-fire botanical studies differing from those of the earlier study. A post-fire botanical survey scheduled for spring 2019, is planned to provide additional information about the variables optimising fire benefits in ESBS recovery. These results will also be complemented by the use of pre- and post- fire UAV survey results.

Results

As previously reported (Lambert et al. 2015; Lambert and Lambert 2015), both quadrats of ESBS that retained a rich and diverse species mix prior to the controlled burning and those that had become species poor and dominated with Coastal Tea-tree (*Leptospermum laevigatum*) each increased in species richness and density in the initial 12 months after the burn.

These changes were greater in burnt quadrats than in adjoining quadrats in which dominant Coastal Tea-tree (*Leptospermum laevigatum*) and Tree Broom Heath (*Monotoca elliptica*) had been selectively removed by thinning (Figure 1).

In all cases, fencing to prevent the impacts of rabbits and other herbivores was essential to recovery of the vegetation, with burnt areas that were fenced containing almost twice as many individual plants as did burnt but unfenced areas. The number of plant species (Figure 1), the

native plant cover and the average height of plants were also greater in the fenced areas 12 months after the burn (Lambert and Lambert 2014).

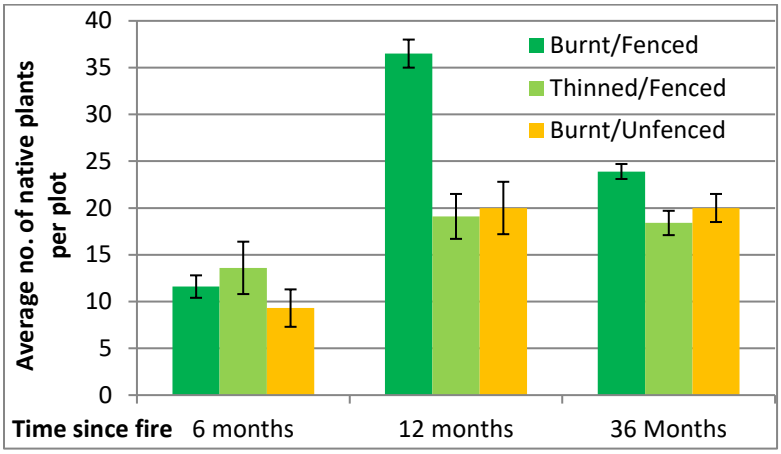

Figure 1: Native plant species responses at intervals after hazard reduction burn or selective thinning. Plant numbers expressed as Mean per plot ± Standard Error.

However, as time post-fire has progressed, the number of ESBS species has steadily increased from 12 months post-fire (Figure 2), but the contrast between pre- and post-fire species mix has changed to an ecological community less clearly that of the Critically Endangered ESBS that we are seeking to restore (G Lambert, unpublished data).

Figure 2: Number of ESBS species found across all plots in burn sites at intervals following the 2012 burn
* Note: The species identifying ESBS were reclassified in 2017 but for comparative purposes the above counts relate to the earlier identification of ESBS.

Discussion

Fuel reduction burning provides a valuable opportunity to conduct botanical studies providing data to enhance our understanding of fire as a tool in restoring coastal heathlands, and in particular the nationally Critically Endangered Eastern Suburbs Banksia Scrub occurring in Sydney.

Burning is a more valuable tool in this regard than is selective thinning of species such as Coastal Tea-tree, which can become dominant in undisturbed ecological communities. However, both the variables (such as fire intensity) associated with a particular burn, and the extent of other disturbances (such as soil disturbance) due to past uses appear to be factors that require further investigation.

Conclusions

Prescribed fire is not the panacea for managing bushfire risk; nor a method that is guaranteed to restore Critically Endangered Ecological Communities, yet the research undertaken at two sites (North Head and La Perouse) demonstrates that risk minimisation through prescribed burning and maintenance of significant ecological communities can coexist when the vegetation is managed with a holistic approach to achieve this.

Further ecological research before and after prescribed burns has potential to yield improved understanding of the variables that will enhance this co-management.

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