MANAGING FIRE SENSITIVE ECOSYSTEMS IN FIRE PRONE ENVIRONMENTS

Extended Abstract
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INTRODUCTION

A Mediterranean-type climate and flammable vegetation have ensured that fire has shaped south-west Western Australian ecosystems for tens of thousands of years (see Abbott and Burrows 2003). Embedded in a flammable and fire-resilient landscape are a variety of 'fire sensitive' and fire-regime specific ecosystems, including riparian systems, peat wetlands and rock outcrops known locally as monadnocks or inselbergs. The flammability of the vegetation assemblages within these landscapes varies depending on the vegetation's physical properties and seasonal moisture regimes. These characteristics determine the periods throughout the year when these assemblages are likely to burn. Typically, vegetation types that are most flammable, and are available to burn for longer periods, contain plants that recover relatively quickly after a fire (fire tolerant). Conversely, less flammable parts of the landscape provide habitat for plants (and animals) that are less resilient, or more sensitive to fire, typified by plant species that are readily killed by fire and have long juvenile periods, or take longer to recover from fire (fire sensitive). While species vary in their sensitivity to fire, most species and communities require fire at some stage of their life cycle for their persistence (Abbott and Burrows 2003).

Monadnocks embedded in a matrix of forests and woodlands are the remains of an ancient land surface that was thought to have been stripped away some time between the Middle Jurassic and the Eocene (Clarke 1994). They are a prominent feature of the Monadnocks Conservation Park, a 31,000 ha area of bushland some 75 km south east of the city of Perth in south-west Western Australia. Monadnocks are important, functioning as biotic islands because of their often distinctive biotic assemblages (York Main 1997). They are thought to be fire refugia for ancient Gondwanan relicts, and other fire sensitive species that are only associated with rock outcrops, so there has been a deliberate management strategy over the last two decades or so to limit the use of prescribed fire in the landscape and to attempt to suppress wildfires. In summer 2003 this strategy culminated in a large and intense lightning-caused wildfire that completely burned the monadnock communities, providing a unique opportunity to document the impacts and early post fire (first 3 years) recovery of these ecosystems and to re-assess fire management.

METHODS

Mt Cooke is a large, prominent monadnock within the Monadnocks Conservation Park. Its summit is characterised by large sheets of moss and lichen-covered granite and rock piles. The vegetation is very diverse, varying in composition and structure over short distances in response to soil characteristics, changing from pincushion (*Borya sp.*) meadows, moss swards, herb fields, heaths, woodlands and eucalypt forests within tens of meters. Stands of Darling Range Ghost Gum (*Eucalyptus laeliae*) grow on the summit and slopes. Many plants including *Acacia ephedroides*, and *Calothamnus rupestris* are restricted to granite outcrops in this region. These species, like many others that grow amongst the rock piles, are readily killed by fire (fire sensitive) and rely on seed stored either in the soil or in the canopy for regeneration. While these species are fire sensitive, they are also fire maintained, rarely regenerating in the absence of fire, but regenerating prolifically from seed following a fire. On a warm, dry summer day in January 2003 a lightning strike in jarrah forest north of Mt Cooke sparked a wildfire which burnt more than 18,000 hectares of bushland over three days. It was the largest wildfire in the northern jarrah forest region since 1961 and one of the largest on record. Driven by north west winds, and burning in long unburnt, heavy and dry forest fuels, the wildfire developed quickly, displaying extreme behaviour as it burnt fiercely up the slopes and along the spine of Mt Cooke and southwards for another 25 km or so. With the fire front generating intensities of 10,000 to 20,000 kilowatts per meter, and flames in the order of 10 to 20 meters high, this wildfire was impossible to stop at its peak, only being brought under control when weather conditions abated and the fire ran into forests carry low fuel as a result of an earlier prescribed burn. Forests, woodlands and wetlands that were long unburnt and carried heavy fuel loads prior to the wildfire, were either totally defoliated or fully scorched. The vegetation on the summit of Mt Cooke was also completely defoliated or was severely scorched and charred by hot gasses and radiation. This presented an opportunity to document the immediate impacts of wildfire on a monadnock ecosystem and to monitor the recovery of the vegetation, in particular, post-fire regeneration strategies and age to first flowering. This was achieved by regular (4-6 weeks) visits to the slopes and summit of Mt Cooke and a) documenting plant regeneration strategies (whether seeders or resprouters) and age to first flowering, b) making observations of other phenomena such as soil erosion, c) determining the extent of mortality to overstorey tree species from a series of belt transects and d) quantifying post-fire changes in plant species assemblages and abundance measured from 120 $1m^2$ quadrats.

RESULTS AND DISCUSSION

Some 68% of all vascular plant species occurring on Mt Cooke, including the mid-slope forests, resprouted either from below ground organs or epicormic shoots. The remainder regenerated prolifically from seed, either stored in the soil or in woody capsules on the plant. However, of the plant species that grow specifically on the shallow granite outcrop soils of Mt Cooke, the ratio of resprouters to seeders was almost the reverse, with about 74% of plants being obligate seeders. In spring, after the first winter rains, there was a proliferation of seedling regeneration of a diversity of trees, woody shrubs and herbs. By three years after the fire, the understorey vegetation had regenerated strongly, except on patches where water erosion had removed the topsoil or where the fire was so intense that it sterilised the topsoil. About 75 species (~50%) had flowered within the first year of the fire; by two years about 120 species had flowered (~78%) and by 3 years, 146 (~96%) species had flowered. Several fire sensitive and keystone species, including *Calothamnus rupestris*, *Acacia ephedroides* and *Thryptomene sp*, which were killed by the fire, regenerated prolifically from seed but had not reached flowering age by 3 years post-fire. Plant species diversity in the early years post fire was high, with an average of 16 species m^2 and a maximum of 32 species m^2 being recorded in the quadrats, reflecting the co-existence of woody shrubs and perennial grasses and herbs (longer lived species) and fire-stimulated annual herbs and grasses (short lived species). The first winter rains also exposed a most sinister consequence of high intensity wildfires – soil erosion. Without the protection of vegetation, live or dead, sheet and gully erosion on the steep slopes of Mt Cooke resulted in topsoil being washed into creeks and streams. The soil on monadnocks is very often a thin, life supporting mantle that overlays the impenetrable rock substrate. Apart from organisms such as lichens and mosses that are able to colonise the rocks, most other forms of life on monadnocks are dependent on the soil mantle, the depth of which varies from a few centimeters where the pincushion meadows (*Borya sp.*) and herbfields grow, to a meter or so, where the woody shrubs and trees grow. Because the soils associated with rock outcrops are shallow and high in the landscape, they are particularly vulnerable to erosion, with long term adverse consequence for biodiversity.

While the vascular plant understorey is recovering quickly, other important habitats including moss swards and pincushion meadows, of which some 55% and 45% respectively were killed by fire, have not yet shown signs of recovery. Overstorey trees such as Jarrah, (*Eucalyptus marginata*), Marri (*Corymbia calophylla*), Wandoo (*E. wandoo*) and Darling Range Ghost Gum that grow on and around Mt Cooke, were severely impacted by the intense fire. The most severe tree death and damage occurred in heavy long unburnt fuels where the fire was most intense. Least damage occurred in younger, recently burnt fuels, where fire intensity was considerably lower. It is most unusual for mature forest trees to be killed by fire. While many trees have resprouted following the fire, an alarming proportion has been killed. Up to 50% of the large old growth trees, some estimated to be more than 300 years old, were killed, suggesting this may have been the most intense fire these trees have experienced. Mortality rate was lower amongst the small, young trees because they were able to resprout vigorously from below ground lignotubers. By killing most trees back to ground level, this wildfire has significantly changed the structure of the forests on and around Mt Cooke and over much of the 18,000 ha affected by the fire. The forest will recover to its pre-fire state, but it will take many decades.

SUMMARY AND CONCLUSIONS

This wildfire was one of the most environmentally severe fires in the northern jarrah forest region in recent times. It was destined to occur because of a prior well-meaning but flawed fire management strategy to exclude fire. Fires of this scale and intensity are environmentally damaging, pose a serious threat to life and property, are very dangerous and difficult to suppress and are probably unprecedented over the last 300 years. Large areas of heavy fuel loads in long unburnt forests surrounding Mt Cooke, together with warm, dry and windy weather conditions resulted in this large fire, with extreme fire intensity and consequent complete burnout of the landscape. Prior to the wildfire, there existed at least 3 seral stages (post-fire habitat stages) on Mt Cooke summit reflecting patchiness of past fires. The mosaic of vegetation and fire-induced habitats has been drastically simplified over a large area by this wildfire. The forests, woodlands, wetlands and heathlands will recover, but it may take decades. Some impacts, such as loss of topsoil through erosion, are practically irreversible. Surrounded by heavy, long unburnt forest fuels, monadnocks cannot function as fire refuges, but are funeral pyres waiting to be ignited. Excluding fire and allowing fuels in the surrounding landscape to accumulate to high levels over large areas is the wrong management strategy. The regular introduction of low intensity prescribed fire (mosaic patch-burning) in the surrounding fire-tolerant landscape and under seasonal and weather conditions such that the lower flammability fuels (wetter, sparser) on monadnocks and other fire sensitive ecosystems will not burn, is essential to protect monadnock communities from lethal wildfires and to allow them to function as fire refuges. Such a fire regime will also provide seral/habitat diversity at appropriate scales and will reduce the size, intensity, damage potential and suppression difficulty of wildfires.

LITERATURE CITED

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