Background briefings on emerging issues for fire managers from AFAC and Bushfire CRC.

bushfire CRC afac

# FIRE NOTE

ISSUE 28 APRIL 2009

# FIRE AND CATTLE: IMPACTS ON HIGH COUNTRY

**The existing evidence about whether the combined effects of fire and grazing are effective in managing fuel loads and fire risk was scant and inconclusive. This project addresses this research gap with the aim of ensuring that reliable evidence is available in the future.**

## BACKGROUND

Recent major bushfires in 2003 and 2006/07 have focused attention on the management of Australia's montane and alpine ecosystems. For example, 'The National Inquiry into the 2003 Bushfires' received over 500 submissions, many of which addressed aspects of land management policy and implementation in the high country. As well, in March 2007 the Victorian Government established an enquiry, 'Impact of Public Land Management Practices on Bushfires in Victoria'. Its terms of reference addressed the impact of public land management practices on the frequency, scale, and intensity of bushfires in Victoria, including alpine areas.

Two of the most controversial aspects of the management of Australia's high country are the role of grazing in reducing fuel loads, and the effectiveness of prescribed burning in reducing fire risk.

Much research has been conducted into the ecology of Australian alpine ecosystems, particularly with respect to the effects of grazing and fire on hydrology, vegetation cover and species diversity.

However, there have been few studies directly addressing the combined impacts of grazing and burning on fuel accumulation. This is surprising given that grazing, in conjunction with prescribed fire, was previously used to manage large areas of the Australian high plains ecosystems.

One of the key activities of this research is to investigate the interactive effects of cattle grazing and prescribed burning on vegetation structure, species composition and fuel accumulation in snowgum woodlands and subalpine grasslands in New South Wales and Victoria.

## SUMMARY

There has been very little research directly addressing the combined impacts of grazing and burning on fuel accumulation in high country environments. In 2006, the HighFire project began to address this evidence gap by establishing a fully replicated, long-term experiment in subalpine grassland and woodland in Victoria and NSW to investigate the combined effects of cattle grazing and prescribed fire.

Sites are surveyed annually and a laser-based point quadrat apparatus and methodology were designed and effectively applied.

The experimental design allows us to rigorously test a range of hypotheses and answer questions of direct relevance to the management of these ecosystems, such as:

- Is cattle grazing an effective means of reducing fuel loads?
- In the absence of both grazing and prescribed fire, will the flammable shrub layer eventually be replaced by a (less hazardous) grassy understorey?

The valuable data from this project could be used in future to model fire impacts in these environments.

▲ **ABOVE:** EXPERIMENTAL BURN APPLIED TO SNOWGUM WOODLAND ON THE SNOWY PLAINS, NSW, MARCH 2007.

## ABOUT THIS FIRENOTE

Co-authors: Dr Stephen Roxburgh is a Research Scientist from CSIRO Sustainable Ecosystems; Dr Maria Taranto is a Research Scientist at the University of Sydney; Professor Mark Adams is Dean of the Faculty of Agriculture, Food and Natural Resources, at the University of Sydney.

This Fire Note is an update of ongoing research by the Bushfire CRC HighFire Project B5.1 Ecosystem Processes.

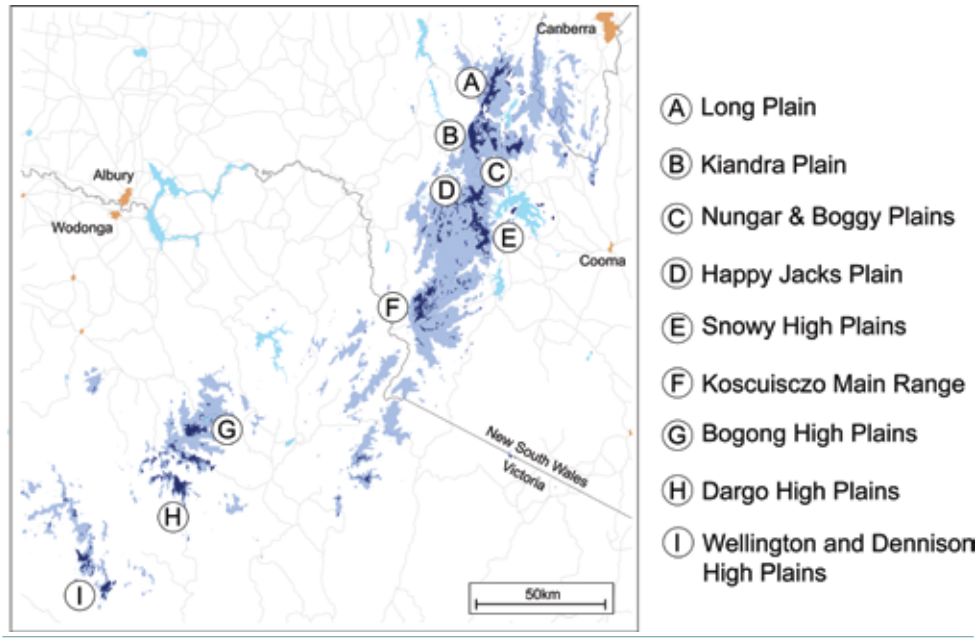
## REFERENCES/FURTHER READING

Roxburgh, S.H. and Taranto, M.T. (2007). A laser point-quadrat sampling frame for vegetation survey. Bushfire CRC. Unpublished report (available via www.bushfirecrc.com)

Roxburgh, S.H. and Taranto, M.T. (2008). High plains grazing and fire trials: Fieldwork protocols. Bushfire CRC. Unpublished report (available via www.bushfirecrc.com).

Levy, E.B. and Madden, E.A. (1933). The point method of pasture analysis. *New Zealand Journal of Agriculture* 46, 267-79.

Goodall, D.W. (1952). Some considerations in the use of point quadrats for the analysis of vegetation. *Australian Journal of Scientific Research*, Series B, Biological Sciences 5, 1-41.




ABOVE: LOCATION OF THE MAJOR NON-FORESTED ALPINE REGIONS IN SE AUSTRALIA. THE LIGHTER BLUE SHOWS ALL LAND GREATER THAN 1300M ELEVATION, AND THE DARKER BLUE THE PREDOMINANTLY NON-FORESTED HIGH PLAINS ECOSYSTEMS.

## BUSHFIRE CRC RESEARCH

Understanding how key human activities (such as management practices), along with environmental factors (including climate change), affect high country environments is critical for managing fuel loads and fire risks. This project aims to contribute valuable data on both fronts that could in future provide the basis for modelling fire impacts in these forests.

### Our approach

We established study sites on private property at the Snowy High Plains, New South Wales, and subalpine grasslands at the Dargo High Plains, Victoria (see graphic above, locations E and H). Both study sites are approximately 1500m above sea level.

The short and long-term responses of the grassland and woodland ecosystems are being measured to experimentally manipulated levels of cattle grazing and burning.

### The treatments

There are four experimental treatments:

1. Ungrazed by cattle and unburnt.
2. Ungrazed by cattle and prescribed-burnt.
3. Grazed by cattle and unburnt
4. Grazed by cattle and prescribed-burnt.

### The sites

Three replicate grassland sites, 100m x 50m, are established at the Snowy Plains and Dargo. Three snowgum woodland sites are established at the Snowy Plains only and are 100m x 100m. All sites are permanently marked and half of each site securely fenced to prevent access to grazing cattle, but allowing access to non-target herbivores such as pigs, wombats and rabbits (pictured below). Each site has four experimental plots for each treatment and was established over the summer of 2006/07. For more information, a thorough description of study sites and fieldwork protocols can be accessed on the Bushfire CRC website at http://www.bushfirecrc.com/research/highfire/research/highfirefuels.html (see Roxburgh and Taranto 2008).

ABOVE: FENCED EXCLOSURE PLOT AT A GRASSLAND STUDY SITE ON THE SNOWY PLAINS, NSW. DOMINANT GRASS SPECIES ARE *POA COSTINIANA* AND *POA HIEMATA*.

### END USER STATEMENT

"Literature on the effects of fire on eucalypt forests and, in particular, the interaction of over and understorey constituents is limited. Research increasing our knowledge about the impacts of fire/grazing and how fire/grazing drives ongoing ecological change is vital in managing these forests and this is particularly so in Victoria's sub-alpine and montane ecosystems.

"This research has clear applications for more accurate modelling of both fire impacts and carbon cycling. Knowledge of carbon cycling is a clearly defined and organisational goal of the Victorian Department of Sustainability and Environment.

"In terms of future work, the reporting of consumption rates associated with fire events still remains a major limitation in the development of models for fire and carbon cycling. We would like to see greater reporting of these rates within all forests of Victoria and see an opportunity to generate this data associated with this project."

**– Scott Arnold, Jaymie Norris and Tom Fairman, the Department of Sustainability and Environment's Land Carbon team.**

### Data collected

The experimental plots were surveyed prior to burning and will be re-surveyed annually. The data collected include various measurements of vegetation structure and ecosystem function, such as measurements of fine and coarse woody fuel loads, species composition, vegetation cover and canopy height, tree mapping, tree diameter measurements (DBH or diameter at breast height), shrub understorey height and cover, and photographs taken from permanent photopoints.

A range of other studies are now being done at these sites, including the assessment of:

- greenhouse gas emissions
- tree water use and stand hydrology
- soil carbon respiration
- soil chemistry.

Fire behaviour measurements recorded during burns and cattle movements will be tracked during several grazing seasons. We developed an innovative advance of a traditional concept that is worth noting: our

LEFT: PHOTOGRAPHIC SERIES FOR ONE OF THE BURNT PLOTS TAKEN ONE WEEK BEFORE THE FIRE (TOP); ONE WEEK AFTER THE FIRE (CENTRE); AND 13 MONTHS AFTER THE FIRE (BOTTOM). NOTE IN THE BOTTOM PICTURE THE RECOVERY OF THE SNOWGRASS, AND THE LOSS OF LIVE TREE CANOPY.

unique point quadrat tool and methodology is described in more detail in the breakout box on page 4 and in the protocols document (Roxburgh and Taranto 2008). The summer of 2008/9 is the third year of collecting measurements.

## RESEARCH OUTCOMES

A key overall impact of the experimental burn was to significantly change the size-class distribution of living trees, with smaller trees more susceptible to fire, and larger trees more vulnerable if they were older or damaged from previous fires.

Major differences in vegetation structure between the grassland and woodland understorey are summarised in the study. The woodland understorey has greater ground-fuel loads, greater shrub cover, and greater average (understorey) canopy height. The ground-layer herbaceous species (tussock-forming *Poa* species and other herbaceous species) show a similar overall cover between the two vegetation types.

Tree maps were also made for the woodland sites, where the location of each individual snowgum (*Eucalyptus pauciflora*) was mapped, the diameter at breast height and bark depths measured, and a record made of whether the tree was dead or alive. These measurements will be re-taken through time to investigate changes to the population structure of the woodland in response to the applied treatments.

Because of the slow growth and response of many of the component species, and the importance of long term year-to-year climate fluctuations, we will need to maintain and monitor the experiment for many years to come.

Three snowgum woodland sites at the Snowy Plains were burnt in March 2007, allowing us to examine, in detail, initial fire effects and patterns and processes of recovery for these subalpine ecosystems (picture series, left). The snowgum woodland plots were re-sampled 13 months after burning, and tree survival recorded. Fire severity varied both within a burn, and between burns. Such spatial patchiness has important implications for biodiversity recovery and refugia (an area from which surviving species may re-disperse after climate change). Across all plots there were, prior to burning, 670 live trees. The impact of the burn was to preferentially kill the canopies of the smaller size-classes, significantly altering the size-class distribution of living trees.

The probability of a tree suffering canopy death declined with size up to approximately 38cm DBH (diameter at breast height), but then rose again. The increased probability of canopy death at larger size-classes reflects greater susceptibility due to natural ageing, and accumulated damage from previous fires.

These patterns of mortality provide a quantitative basis for modelling fire impacts in these forests. They also provide the necessary data to link fire impacts to population size structure, and resulting changes in the size-class distribution (and hence fuel distribution) of the population. The recovery of the trees will continue to be monitored.

## CRC RESEARCH AT WORK

Evidence from this long-term project will significantly improve our understanding of whether the combination of fire and grazing is an effective fuel management practice in the high country. In decades to come, this will enable future generations to make land management decisions that are based on credible research that was not available to their predecessors.

However, in the short term, the evidence is already providing an insight into landscape

## LASER-BASED POINT QUADRAT METHODOLOGY FOR SURVEYING VEGETATION

We designed and built a laser-based point quadrat apparatus for surveying vegetation in grassland and tall shrubland ecosystems. The design is based on the well established concept of sampling vegetation by point quadrat, which is a theoretically sound method for determining vegetation cover (Levy & Madden, 1933; Goodall, 1952). A laser-based method was designed as, unlike the original pin method, it eliminates much of the bias associated with using a pin. The design specifications included:

- the ability to sample vegetation with a canopy height up to approximately 1m, but also be effective in lower-stature vegetation
- the use of a laser point design to ensure visibility in daylight
- apparatus that is lightweight and manoeuvrable through dense shrub vegetation.

The resulting apparatus (pictured right) was highly effective and a detailed description and methodology is available (Roxburgh and Taranto, 2007).

differences among subalpine grasslands and woodlands and the immediate responses to the combined treatments of fire and grazing.

The fire/grazing experiment was established as a long-term experiment to monitor the response of relatively slow-growing vegetation to the effects of treatments conducted periodically (annually and several years apart). Improving our understanding of the combined effects of fire and grazing on the vegetation/fuel dynamics of subalpine ecosystems requires a long-term effort, estimated to be at least several years and perhaps over decades.

The short-term (0 to 10 years) effects of fire on vegetation are easily measured. However, the effects of grazing are much more gradual and apart from the immediate removal of above-ground material, the longer-term effects on species composition may take decades to become apparent. Hence, the combined effects of fire and grazing will also take up to decades to become apparent.

An update of this research and the major outcomes will be available via:

- Fire Notes
- papers in peer-reviewed journals
- the Fire Knowledge Network
- open days at research sites
- further collaborations with end users and other researchers, within and outside the CRC.

Ultimately, data from this experiment will be used, along with data from other High Country Fuels and Ecosystem Functions (HCFEF) projects, to drive a model that would predict changes to vegetation/fuel dynamics in subalpine ecosystems in relation to fire risk.

## FUTURE DIRECTIONS

The fire/grazing experiment is one of five sub-projects of the HighFire Fuels and Ecosystem Functions (HFEF) project and each is investigating an additional, major gap in our understanding of Australian subalpine and montane ecosystems. HFEF is also examining aspects of water and gas fluxes and how they relate to changing climates, fire regimes and management practices.

Specifically, the range of other experiments in progress are examining:

- the flux of water and greenhouse gas from soils in subalpine woodland
- the flux of carbon and water in montane forest, snowgum woodland and subalpine grassland
- the dynamics of soil carbon in snowgum grassland
- methane oxidation in montane forest.

We continue to encourage other researchers (Bushfire CRC and non Bushfire CRC) to use the substantial infrastructure established at the Snowy Plains. To date additional non CRC-funded research undertaken at the field sites include:

- a short-term experiment by researchers at Monash University that examined the influence of past weather patterns on the growth of snowgums, and
- a long-term experiment by Dr Charles Warren from Sydney University, who is examining the influence of water and temperature on rates of photosynthesis and greenhouse gas emissions in subalpine grasslands.

**Fire Note is published jointly by the Bushfire Cooperative Research Centre (Bushfire CRC) and the Australasian Fire and Emergency Service Authorities Council (AFAC).**

**Bushfire Cooperative Research Centre**
Level 5/340 Albert Street
East Melbourne VIC 3002
Telephone: 03 9412 9600
www.bushfirecrc.com
Bushfire CRC is a national research centre in the Cooperative Research Centre (CRC) program, formed in partnership with fire and land management agencies in 2003 to undertake end user focused research.
Bushfire CRC Limited ABN: 71 103 943 755

**Australasian Fire and Emergency Service Authorities Council**
Level 5/340 Albert Street
East Melbourne VIC 3002
Telephone: 03 9418 2388
www.afac.com.au
AFAC is the peak representative body for fire, emergency services and land management agencies in the Australasia region. It was established in 1993 and has 26 full and 10 affiliate members.