Mountain Cattlemen conceptual model for the application of grazing and low intensity burning to manage fuel and bushfire risk in Victoria's high country

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Preamble

Members of the Mountain Cattlemen's Association of Victoria (MCAV) claim broad inter-generational knowledge relating to the alpine landscapes in which they graze their cattle. Since the early 1830's, they and their forbears have observed the effects of grazing on vegetation across the geographically diverse sites of their runs in Victoria's high country. They have witnessed first-hand, fire behaviour and its effects in a variety of seasonal weather conditions, in a variety of high country vegetation types, in a variety of different growth stages. Mountain cattlemen have more than one and a half centuries of making such observations, trying out different grazing management and burning practices, and continually refining their practices based on their observations. Contemporary natural resource management theory and terminology calls this approach 'adaptive management'. Mountain cattlemen are among the most experienced 'adaptive management' practitioners in Australia.

Knowledge accumulated over several generations of adaptive management has been passed on from one generation to the next. It is simply not practicable to conduct longitudinal scientific experiments covering the timespans and variety of conditions and circumstances that mountain cattlemen have observed over several generations. Accordingly, MCAV believes their accumulation of knowledge gained from long term adaptive management, should be afforded equal status to knowledge gained from more formal longitudinal studies. This paper has drawn heavily on the mountain cattlemen's accumulated knowledge on the links between grazing and low intensity burning on vegetation and fuels, and in turn, on fire behaviour and risk in the high country.

General notes on interpreting the conceptual model and sub-models

In accordance with the project scope of work and specifications, GHD has organised the information provided by MCAV into a conceptual model of traditional high country grazing and burning and its effects on bushfire risk reduction. The conceptual model (on the following page) presents a summarised, high level overview of how mountain cattlemen's traditional grazing and burning practices impact the fuel characteristics of the main high country vegetation groups, how this effects fire behaviour, and ultimately how this translates to reducing bushfire risks across the high country landscape. In the conceptual model, numbered notations refer to more detailed sub-model descriptions:

The sub-models provide more detailed and explanatory descriptions of the key components of the high level conceptual model. These are compiled from MCAV's inter-generational knowledge, as captured through three workshops, two field trips and a number of one-on-one interviews and follow up consultations. Although a literature review was not part of this work, some references to which GHD was referred by MCAV members have been cited.

Conceptual model of traditional high country grazing and burning: effect on bushfire risk reduction

Inputs

High country vegetation state*

* Upon arrival of pioneer cattlemen

Open grassland areas: Healthy open-clumped grassland, easy to walk/ride through, highly palatable to stock, kept open and short by low intensity lightning fires and Aboriginal burning.

Grassy sub-alpine woodlands: (mostly snow gum and black sally) Open cover of mature trees (easy to ride through) with vigorous open-clumped snow grass, favourable for grazing. Low intensity lightning fires and Aboriginal burning kept grassy understorey open and easy to walk through.

Woodlands with mixed grass/shrub understorey: Taller mixed species stands at lower elevations with grassy understorey with scattered shrubs – easy to ride and move cattle through. Unrestrained lightning fires and Aboriginal burning maintained grass dominance; easy to move stock through; adequate feed for stock.

Other vegetation not grazed by stock:

Scrub dominated rocky patches, forests with little grass cover.

Grazing[1] (and burning[2]) practice

Extent: Grazing in grassland, grassy woodlands and grassy forest extensively across high country to above tree line.

Grazing cycles: At lower elevations – all year round while ever there was sufficient grass to maintain stock condition. At higher elevations (above ~800m) stock taken up late spring and brought down as first big autumn frosts arrived.

Stocking levels: According to seasonal conditions, stocked to level at which herd maintains/improves condition. Historical stocking levels (when burning was allowed) were higher than more recent levels.

Burning: Grazing conducted in conjunction with ongoing patch-burning. Burning conducted in grasslands, grassy woodlands and 'bush runs' wherever rank grass or shrubs had accumulated to levels sufficient to carry low intensity fire. There was no fixed cycle for grazier burning – selection of patches/areas for burning was based on condition assessment. Intervals between burns in grassland/grassy woodland, were typically around 6-7 years in lightly or ungrazed areas, and around 4 years in more routinely grazed areas.

Immediate effects

Effect of grazing and grazier burning on vegetation and fuel characteristics[3]

Open grasslands: Grass kept short, open-clumped and mostly green even through summer. Grass response to grazing and burning was strong growth of fresh green grass during the growing season. Inter-tussock spaces were kept open, favouring a variety of herbaceous ground cover plants. Grazing and burning inhibited proliferation of woody shrubs, maintaining dominance of grass and diverse herbage.

Grassy woodlands (snow gum/black sally): Grass kept short, open clumped and mostly green. Sparse/patchy shrub presence in understorey maintained.

Grazing and low intensity burning prevented woodland 'thickening' maintaining an open cover of mature trees (regeneration of young trees was mostly associated with occasional disturbance events such as higher intensity summer fires or after rabbit plagues).

Negligible ladder fuel between short grass understorey and overstorey tree canopy.

Woodlands with mixed grass/shrub understorey: New-season grass grazed short, rank grass remains, some shrubs browsed but not removed. Low-intensity burning maintains a grassy understorey dominated by young grass, and prevents increasing shrub domination. Juvenile shrubs may be killed in burnt patches, but larger, adult (low-intensity fire tolerant) shrubs remain in burnt and unburnt patches. Burning chars bark on fibrous barked tress, and reduces leaf litter and suspended bark (reducing ladder fuels).

Areas where grazing and burning are excluded: Snow grass clumps grow accumulating dead thatch with each growing season, crowding out inter-tussock spaces and creating a dense accumulation of fine fuel (flammable under a wide range of conditions). Shrubs increase in extent, cover and height with ongoing absence of fire. A low frequency, high intensity fire regime promotes shrubby understorey thickening. Fibrous barked Eucalypts accumulate flammable bark and add leaf/twig litter to understorey grass and shrub fuels.

Intermediate effects

Vegetation/fuel effects on fire behaviour[4]

Grazed grasslands: Short, open-clumped and mostly green grass will not carry fire even through summer. In recent severe fire events (2003 & 2006), many recently grazed open high country grassland areas did not burn, providing survivable refuge for stock, firefighters, and equipment. Fire may cross short grazed areas as embers from forests and woodlands.

Grassy woodlands (snow gum/black sally): In mature snow gum/black sally stands with short grazed grass, fires burning in extreme weather will not burn or reduce in behaviour to a low intensity surface grass fire. Rate of spread and fire intensity are reduced by the low grass fuel availability and short structure, and by the wind speed reduction effect of the tree canopy. The extent of full crown scorch is significantly reduced.

In recent extreme fire events, fire behaviour in short recently grazed snow gum stands has been reduced so as to prevent significant tree mortality.

Woodlands with mixed grass/shrub understorey: In grazed and low-intensity burnt woodlands with mixed grass/shrub understorey, summer bushfire behaviour is typically reduced to a surface fire (significantly reducing crown fire except on steep uphill runs and high fuel patches). Where grazing only is carried out (no low intensity grazier burning) fire behaviour is not significantly altered due principally to near-surface and elevated shrub fuels and extreme bark hazard.

Areas where grazing and fire are excluded: Long-ungrazed and unburnt snow grass will burn vigorously in a wide range of conditions when fire gets in to dead thatch accumulations (abundant very fine fuel which is easily ignited). Snow gum woodlands with long-unburnt and ungrazed grass or shrubby understorey can support crown fires and will support a vigorous surface fire likely to result in complete and widespread scorch and tree mortality. Long-unburnt grassy/ shrubby woodlands may support intense surface fires and crown fires.

Long-term effects

Landscape fire impact and risk reduction[5]

The effect of high country grazing and traditional burning practices is to:

- reduce the extent to which summer bushfires spread in high country landscapes (due to lowering rates of fire spread), particularly reducing the likelihood of fires crossing high alpine plateaus
- lengthening the interval between high intensity/impact fire events
- significantly reducing the impact of bushfires on thin-barked woodland tree species such as snow gum which are killed if they suffer full crown scorch
- significantly reducing the extreme soil erosion impacts that arise when large scale high intensity fires remove tree cover and burn long-accumulated snow grass thatch at high intensity
- Increase the resilience of high country ecosystems to summer bushfires by avoiding large scale fuel accumulations, (summer fire impacts are patchier with greater variety in fire intensity)
- Increasing the opportunities for control of unplanned summer bushfires by increasing the extent and connectedness of low fuel areas where fire behaviour will moderate allowing suppression
- Reducing the potential for catastrophic fire impacts in sensitive systems (eg. moss beds and peat bogs) by reducing fuel around these such that summer fires do not burn into these features

Note: For landscape scale risk reduction benefits to be realised, alignment and distribution of grazing runs along a large extent of ridge/ plateau systems is required. Small scale piecemeal grazing can only achieve small scale localised risk reduction and cannot achieve broader landscape scale benefits . Grazing without burning will significantly limit effectiveness.

Sub-model 1 - Mountain cattlemen grazing practice

High Country Cattle Grazing Practice:

Notes:

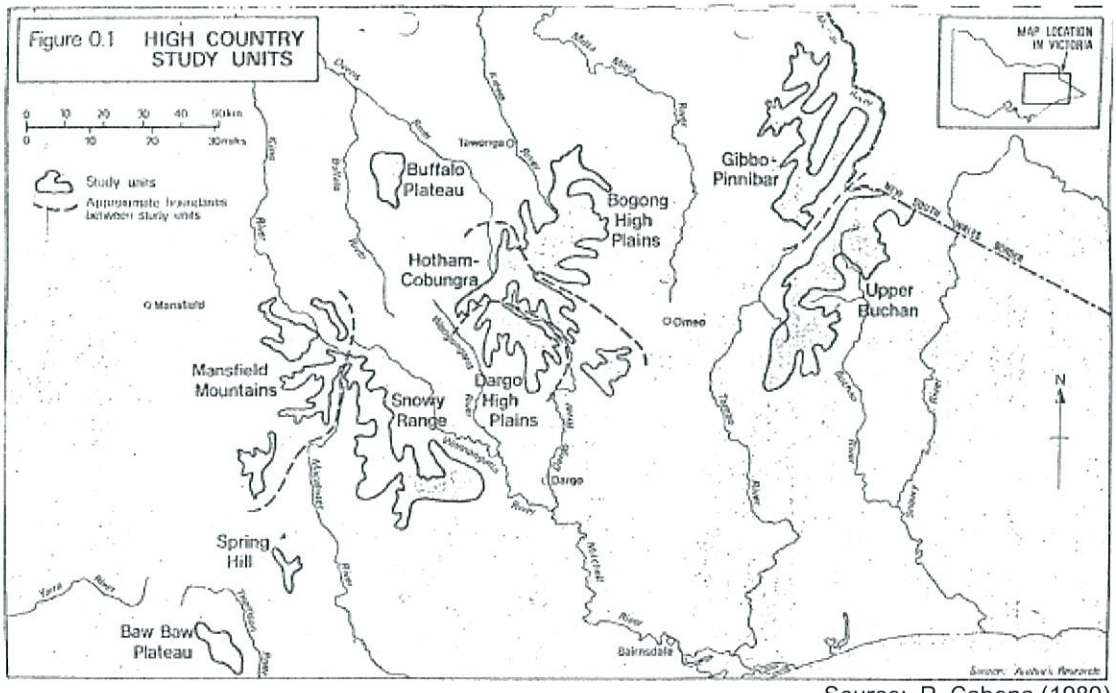
a. By necessity, practices vary from location to location according to local conditions and circumstances. The grazing practice characterisation in this sub-model outlines the most prevalent practices but does not attempt to document the full variety of practices
b. Traditional high country grazing practice was inextricably associated with burning (see burning sub-model for mountain cattlemen burning practices)

Traditional grazing practice:

Where:

Grazing occurred on licensed grazing runs which covered most accessible (not too steep or heavily forested) high country areas. The following Victorian high country landscapes, among others, have a history of high country grazing:

- Mansfield mountains
- Snowy range / Wonnangatta / Ti tree range
- Bogong high plains
- Hotham-Cobungra high plains
- Dargo high plains / Blue Rag
- Buffalo plateau
- Gibbo-Pinnibar range
- Upper Buchan range to Nunniong plateau
- Spring Hill, Mt Useful, Mt Skene
- Baw Baw plateau



Source: P. Cabena (1980)

Grazing extended from private property down in the adjacent lowlands/valleys all the way up to grassy high top areas above the tree line to the summits of all the major mountains (about 1800m).

Generally, across the high country landscape, grazing leases were comprised of the following broad vegetation groups:

- open grassland – generally averaging from 5 to 20% of runs depending on location (alpine grasslands and natural sub-alpine grasslands below the tree line - eg in frost hollows)
- open sub-alpine woodlands (eg. snow gum (*Eucalyptus pauciflora*) and black sally (*Eucalyptus stellulata*) with a grass dominated understorey - generally averaging 25 to 30% of runs (for some specific runs this can be as high as 95%)
- the remainder of run areas were either:
  - grassy high elevation tall forest (eg. alpine ash, mountain gum), or
  - lower elevation mixed species woodland/dry open forest with mixed grass and shrub understorey (ratio of grass to shrub cover strongly influenced by burning history), or
  - vegetation unsuitable for grazing including montane wet forest, scrub and alpine vegetation types.
  - Peat bogs/sphagmum moss beds (which are mostly avoided by cattle)

[Note: Grazing runs have been greatly reduced from traditional areas, with significant step-change reductions occurring over time. These reductions have been in part from the adaptive management of cattlemen, and in part due to changes in government policy]

What:

Cattle grazed/browsed different plants at different times in a migratory fashion. Cattle prefer new-season, nutritious, 'sweet' young grass shoots to older grass. At higher elevations (alpine and sub-alpine areas) the principal grass grazed by cattle is snow grass (Poa spp). At lower elevations Kangaroo grass (Themeda spp) and Wallaby grass (Austrodanthonia spp) are the principal grasses grazed in woodlands. There are also increasing numbers of Sambar deer and horses grazing, which graze some different plant species to those grazed by cattle.

One study of high country cattle grazing habits (van Rees, 1982) identified cattle favouring snow grass shoots early in the season (early summer), and young shrub seedlings/growing tips of some palatable shrubs, and forbs along with grass with seed heads (in autumn). In general, as preferred food plant biomass was reduced in easier, favoured country, cattle progressively moved into less favourable areas where they had to work harder for their feed.

Cattle will by choice move to areas containing higher quality, more digestible and nutritious feed. Active management of cattle is required to spread grazing effort across less productive/ palatable areas of licensed runs. Cattlemen have to encourage their cattle to move through favoured feeding areas to less favoured areas at the furthest extent of runs (driving cattle and holding with salt licks) to spread grazing across the fullest extent of a run.

Generally cattle will avoid less palatable vegetation types (eg. Alpine scrubs and low nutrition value vegetation in rocky areas) and vegetation situated in difficult-to-graze situations such as in alpine and sub-alpine bogs/mossbeds. If easier alternatives are not available, they may cross alpine bogs to gain access to favoured sites, or to access water (if water sources near firmer ground are not available). Peat bogs are observed to be a favoured habitat and wallowing area for Sambar deer.
Southerly aspects are often avoided by cattle in the cooler months but grazed in the middle of summer.

When:

Local climatic conditions prevailing in Victoria's mountain landscapes are the primary constraining factor affecting when licensed high country grazing runs can be used. Native grasses in high country areas respond to heavy frosts (typically commencing in mid autumn) becoming frost-cured, losing nutritional value for stock, and commencing their cold season dormancy period. Increasing snow cover and sustained cold temperatures render the alpine, sub-alpine and montane elevations too hostile for cattle. Therefore, high country runs above approximately 800 metres elevation typically do not support cattle grazing from late Autumn until late Spring, and all of winter.

The timing of when cattle are moved to different parts of the high country is variable depending on a range of factors including:

- The effect of longer-term seasonal conditions (eg. drought, extent and amount of snow cover) on landscape productive capacity;
- The timing of cyclic weather events (eg. late snowfall, early snow melt, early frosts, late frosts, cold snaps and high rainfall periods)
- The condition of feed in home paddocks;
- The impact of pest animals (eg rabbits) on pasture availability
- When the spring flush begins – people had their own indicators in their area

Decisions to move cattle from home paddocks (or low elevation runs) to high country is invariably based on a condition assessment, by license holders, of the high country runs to determine when they will be 'ready', and also the condition of the cattle and home paddocks.

Traditional practice:

- 12 month leases were the norm, but high country runs are generally only grazed from November to May/June depending on season, individual and elevation;
- Some cattlemen grazed lower elevation runs all year round, others moved stock to low elevation areas for winter – especially lower elevations such as below 800m
- When cattle were up on high country runs, cattlemen regularly attended to the cattle to move them around the run , at times remaining camped with cattle for extended periods

How much - stocking rates:

The numbers of cattle taken up to different parts of the high country is variable depending on a range of factors, informed by more than a century of inter-generational knowledge and experience gained from long-term adaptive management. Factors influencing stocking rate decisions include:

- The numbers of stock owned/managed by the license holder in a season;
- Seasonal conditions and feed availability in the licensed runs.

Maximum stocking numbers for each run based are based on sustainable practice. Typically, traditional stocking rates were higher than current rates. This is due to a range of factors including license condition changes, but significantly also, the reduction in extent and quality of grassy feed arising from the prohibition of burning, active fire suppression, and a general reduction of low intensity burning in the high country.

Stock moved up to the high country is typically a mix of older cattle and younger cattle and calves. The older cattle, which have many seasons experience grazing in a licensee's run, have accumulated 'local knowledge' of conditions and routes in the runs. Younger cattle tend to follow the older cattle and thus learn from their experience. The result is that cattle rarely stray from a run, find their way to favoured feeding areas more easily (and avoid not-so-favourable areas), and are easier to drove to home paddocks because they know the way.

Stocking rates have reduced significantly over recent decades.

Case study examples:

> Nunniong run supported up to 2000 head all year round prior to the banning of grazier burning. Current stocking rates are up to 800 head during a restricted stocking period typically now from Christmas to 25 May.
>
> In the early 1930's, stock numbers on the Bogong High Plains were estimated to be around 6,500 head of cattle. During periods of severe drought, under relief grazing arrangements administered by the Government, stocking levels were raised well above normal levels with significant numbers of starving stock depastured to the Bogong High Plains. In 1908 , cattle numbers on the Bogong High Plains were reported to have been 12,000 head which was three times the normal level at that time. In 1902/03 in addition to cattle it is estimated 40,000 sheep were depastured on the Bogong and Hotham high country (Cabena, 1980).
>
> Between the late 1930's and 1970's, stock levels on the Bogong High Plains were cut back considerably.

Why?

There are a range of reasons why cattlemen have run, and seek to continue running cattle in the high country. These include:

- As a drought management strategy – higher precipitation, cooler temperatures and lower evaporation at higher elevations provide palatable grass cover at times when drought affected pasture conditions on grazing properties at lower elevations cannot maintain cattle condition and health. Movement of stock to higher elevation native grasslands and grassy woodlands provides drought relief, and allows a degree of recovery for low elevation pastures that would otherwise be completely eaten out, exposing topsoil to erosion, and requiring hand feeding of stock.
- High country grazing in Victoria's alpine region is a significant aspect of local culture and heritage. Local communities value the grazing tradition, and the people involved in high country grazing place a very high value on inter-generational connection to the land (and don't want to see high country grazing knowledge lost);
- Tourism is a most significant contributor to regional economies, with the image of high country grazing having iconic status (regionally, nationally and internationally) and representing a significant drawcard for tourism. High country grazing families are 'tradition bearers" whose activities bring regional education and economic benefits extending well beyond their farm gate.
- Cattle grazing within licensed runs is an important fire management tool which provides a significant degree of mountain landscape fire protection (from high intensity fires), well beyond the boundaries of individual runs. High intensity fire-sensitive ecosystems, iconic within the Victorian Alps environment, and to which mountain cattlemen are inter-generationally connected are afforded a significant degree of protection by the occurrence of cattle grazing.
- Cattlemen consider that sustainable high country grazing and grazier burning can contribute to good public land management. Contemporary high country landscapes are affected by weeds, pest animals, and illegal human activities on public land. High country ecosystems have over many millennia, evolved with and adapted to low intensity fires started by lightning and Aboriginal people. Traditional burning by Aboriginal burning ceased more than 150 years ago, and over recent decades fire suppression with modern firefighting technology has seen the vast majority of lightning-caused fires extinguished such that they now burn only a small fraction of the area they used to cover – hence low intensity fire has been removed from high country landscapes to a very significant degree. The grazing and burning practices of cattlemen compensated to a significant degree for this removal of Aboriginal burning and lightning-caused low intensity fires. Well managed grazing and burning practices by cattlemen in high country landscapes can supplement taxpayer funded public land management agency efforts to manage fire, pests and weeds, and keep access for essential high country management open and safe

to use. In particular, prevention of fuel accumulation on a broad scale achieved through annual grazing and periodic low intensity burning is important to prevent or reduce the occurrence of high intensity fires which are a major threat to many alpine and sub-alpine species. Locally based cattlemen with comprehensive local knowledge of local landscapes and issues, and knowledge of how to graze and use fire in the high country, and who spend a significant proportion of their time moving around in the high country landscape are in an unparalleled position to contribute to good public land management outcomes.

Sub-model 2 - Mountain cattlemen burning practice

Mountain Cattlemen Burning Practice:

Notes:

a. By necessity, traditional burning practices vary from location to location according to local conditions and circumstances. The burning practice characterisation in this sub-model outlines the most prevalent practices but does not attempt to document the full variety of practices

b. Traditional high country grazier burning practice was inextricably associated with grazing (see grazing sub-model in previous section). These burning practices were aimed at maintaining native vegetation in the condition it was found when graziers first moved cattle into Victoria's high country through the nineteenth century (open grassy woodland areas that were easy to ride and move cattle through, and which had a grass dominated understorey that was attractive and palatable to cattle).

c. The current condition of high country grasslands, woodlands and grassy forest types has been significantly altered by modern fire suppression, forced cessation of grazier burning, rabbit and other pest animal plagues, and an increasing recurrence of large high intensity wildfires. The condition of some grassland, grassy woodlands, and formerly grassy forests has been altered to such a degree that it will now take previously unnecessary restorative burning and grazing over significant areas and time periods to restore the health and condition of these ecosystems to something approaching their former states.

Traditional burning practice:

Where:

Burning by cattlemen occurred on licensed grazing runs which covered most accessible (not too steep or heavily forested) high country areas, and woodlands at lower elevations. The following Victorian high country landscapes, among others, have a history of grazier burning:

- Mansfield mountains
- Snowy range / Wonnangatta / Ti tree range
- Bogong high plains
- Hotham-Cobungra high plains
- Dargo high plains / Blue Rag
- Buffalo plateau
- Gibbo-Pinnibar range
- Upper Buchan range to Nunniong plateau
- Spring Hill, Mt Useful, Mt Skene
- Baw Baw plateau

Burning was conducted throughout most of the altitudinal range of Victoria's high country, in lowlands/valleys all the way up to grassy high top areas above the tree line (about 1800m).

Graziers applied low intensity patch burning practices (typically burning some but not all of the rank grass, understorey vegetation and leaf litter in grasslands and grassy woodland/dry open forests) in the following systems:

- Some alpine areas above the tree line (above 1800 metres) – very limited burning in grasslands, mostly targeted to tussocky type grasslands on the broader open plateaus;
- Most but not all sub-alpine woodlands and grassland ecosystems;
- Some grassy montane forest systems (including mountain gum and alpine ash, in which grassy understoreys were kept open by grazing);
- Most but not all lower elevation mixed species woodlands and dry open forests with mixed grass/shrub understoreys

Burning was undertaken across the major proportion of grazing runs to keep them open (preventing shrub invasion) and producing young vigorous grass attractive to cattle. Burning was undertaken in fire prone woodlands and dry forests below sub-alpine areas to reduce the extent and intensity of summer fires moving from lower to higher elevations where ecosystems are more sensitive to high intensity fire. Burning was also undertaken along access routes, as stock were moved to lower elevations, to keep routes open, preventing shrub invasion.

Burning was also undertaken, often at the higher frequencies possible, in woodlands immediately adjacent to home paddocks, cattleyards and property to reduce fire risk to cows and calves in home paddocks, farm infrastructure and houses.

Grazing and burning was also undertaken along roadsides, reducing fire hazards for communities, and maximising the value of roads as features from which summer bushfire containment could be undertaken.

Burning was excluded from:

- More exposed areas of snowgum where the lower branches are very close to the ground;
- Areas of juvenile snowgum regrowth – typically snowgum needs to be around 20 years old before you can burn under it successfully (there needs to be a gap between the grass and the snowgum canopy so the fire doesn't get into the snowgum crowns and full canopy depth scorch is avoided). Cattle grazing is the best means of fire protection for juvenile snowgum;
- Juvenile alpine ash – cattle grazing is the best way to protect young Alpine Ash regrowth up to about 10 to 15 years old. Burning was not undertaken until pioneer hop scrub understorey had died out.
- Riparian habitats in order to protect streams
- Alpine herb fields
- Mountain plum pine and scrubs on the rocky higher elevations
- Cypress pine dominated woodlands – cattle grazing is the best protection against high intensity fire in these areas.

What and how often:

Low intensity burning was conducted at a range of intervals in the following broad vegetation groups:

- Some but not all natural open grassland areas in alpine, sub-alpine zones were burnt periodically, depending on the extent to which grazing prevented the accumulation of dead grass (more intensively grazed grassy areas, grazed with sufficient intensity to keep grass short and green, were not burnt). In annually grazed grasslands, burning intervals were typically in the order of around 6 to 7 years (some higher elevation alpine grasslands and more intensively grazed sub-alpine grasslands were not burnt at all)
- Alpine and sub-alpine bogs and moss beds were not burnt. Grassy areas on higher dryer ground around bogs were more often grazed than burnt as these areas were kept green by grazing grass around bogs such that they wouldn't carry a summer fire.
- Most but not all open grassy sub-alpine woodlands (eg. snow gum and black sally) with a grass dominated understorey were burnt. In annually grazed grassy woodland areas, burning intervals were typically in the order of around 6 to 7 years (some more intensively grazed sub-alpine woodlands were not burnt at all). Lightly grazed or ungrazed woodland areas where rank grass accumulation accrued annually were burnt at intervals around 4 years. Burning interval depended on the amount of flammable fuel that had built since the last burn.
- Some higher elevation montane forests with grassy understorey (eg. Mountain Gum (*E. dalrympleana*)) were burnt as frequently as rank grass sufficient to carry fire accumulated, whilst grazing was preferred in fire sensitive Alpine Ash (which has thick flammable fibrous bark and can be killed by a vigorous grass fire if it gets sufficiently hot)
- Most but not all lower elevation mixed species woodland/dry open forest with mixed grass and shrub understorey in which stock grazed were burnt periodically. Burning was in mostly in patches with different areas within a run burnt each year, on a cycle such that most areas were burnt at intervals of around 4 to 7 years. Bush runs closer to home paddocks were burnt at higher frequency (4-5 years) and back country runs at lower frequency, typically 6 to 7 years.

Note: Burning in licensed runs has been banned in most areas since about the 1940's, however, in some areas unofficial burning continued into the 1950's and 60's.

When and how:

Seasonal climate dynamics in the Victorian high country are the dominant influence on when and how cattlemen undertook burning in different vegetation types.

Alpine and sub-alpine grasslands: These areas are frequently under snow during winter (and often also in late autumn and early spring). Cattle and therefore cattlemen were not normally present at high elevations at these times and therefore there was no burning in the alpine and sub-alpine grassland areas during this period. As snow cover receded progressively in spring, soils in grassland areas were typically wet or moist from melting snow, thawing ground and late winter/early spring rain. The spring

'thaw' is routinely followed by a flush of green growth which increasingly inhibits burning and is the emergent food source for cattle later in the season. Accordingly, alpine and sub-alpine grasslands were either burnt as early as conditions would allow in spring before the post-thaw growth flush commenced or left until after autumn frosts which bring about a step-change increase in grassland flammability. Burning in spring before the growth flush had the added advantage of promoting a vigorous growth response in the new growing season. Grazed grassland areas rarely burnt in summer due to their low dead fine fuel content and high live green grass component, however ungrazed areas with accumulated dead fine fuel can carry lightning (or other) caused fires in summer and into autumn.

Grassy alpine and sub-alpine woodlands: Seasonal fuel flammability dynamics in grassy sub-alpine woodlands is very similar to sub-alpine grasslands, with the general difference that woodlands at the lower elevations of the sub-alpine zone (where snow cover is more intermittent and conditions are generally warmer than at higher elevations) the grassy understorey may support fire for a longer period (from earlier in summer to later in autumn). Burning in grassy sub-alpine woodlands was undertaken mostly following the winter/spring thaw or in autumn, but small isolated patches of heavier fuel (where these were surrounded by low flammability short grazed areas) were burnt during favourable weather in summer on mild days. Grassy sub-alpine woodland burning was patchy (typically ranging from burning of small localised landscape features such as knolls, up to broader areas extending to around 100 hectares). Burning was targeted to areas with sufficient fuel to carry fire under mild summer or autumn conditions. Burning was carried out opportunistically (when conditions were 'right') and intuitively (in areas where the grass/shrub condition was considered to need burning to prevent it further accumulating fuel and declining in value for grazing).

Lower elevation woodlands/dry forest with mixed grass/shrub understorey:

Below the sub-alpine zone, woodlands and dry forests of the montane zone and foothills typically have a variable mix of grasses, herbs and shrubs in the understorey. At the time cattle were first introduced to these areas, a high proportion of these woodlands and dry forests had sufficient grass cover that cattlemen found them suitable for grazing stock and they used burning in combination with grazing to maintain their open grassy condition.
Burning was undertaken mostly in autumn, and occasionally in spring. Burning was unbounded. Previously burnt areas, and moist or green areas limited fire spread. Cattlemen typically burnt from different bush tracks in successive years thus creating a mosaic of burn-ages and areas within (and below) their runs. Without burning, grass regeneration was not sufficient to keep cattle from moving out of bush runs. Burns were mostly steady low intensity fires, however, at times, burns in drier country could become more intense, especially on parts where fire ran up hill. However, dry woodland/forest species were well adapted to fire and suffered little damage from spring or autumn burns as hot sections were limited to small areas. Steady low-intensity burns maintained open grassy understorey conditions, however hot burns or fires could promote shrubby thickening. Care was taken to minimise hot fire as this could promote an increase in shrubs.

Frequent woodland burning around home paddocks: The most frequently applied burning was at lower elevations in woodland/dry forest areas adjacent to home paddocks. Cattlemen knew well the threat posed by summer bushfires to their homes, property and livestock remaining in home paddocks for summer (and to huts on high country runs). Accordingly, many burnt woodlands and dry forests adjacent to their properties/infrastructure as frequently as they could. This burning was often undertaken in early spring as soon as fuels were sufficiently dry to carry fire, so as to minimise the dead fuel available going into summer.

Why did cattlemen burn and still wish to do so?

There are a range of reasons why cattlemen burnt in the high country. These include:

- To maintain the extent of grassy understorey conditions in woodlands and dry forests to prevent increasing expansion and site occupation by shrubs (which proliferate in the absence of fire or when a low frequency-high intensity fire cycle becomes established);
- To reduce space occupied by dead grass thatch and promote the growth of fresh green grass shoots and herbage attractive to cattle;
- To maintain their licensed runs in an open condition through which they could safely ride and move cattle;
- To protect sub-alpine trees sensitive to moderate/high intensity fire (principally snow gum and black sally) from damage by summer fires;
- To promote diversity of grass, herbs and palatable shrubs upon which cattle feed;
- To create a mosaic of low to moderate fuel areas in woodland and dry forest areas to reduce the likelihood of large summer fires developing;
- To reduce the intensity and impact of summer fires occurring in low elevations, montane and sub-alpine areas;
- To provide areas in the sub-alpine landscape where cattle could be moved to for protection/survival in the event of adverse summer fires,
- To keep access/egress routes into and through the high country open and clear to ride and move cattle through.
- To provide a degree of landscape fire mitigation such that fires burning in adverse summer conditions had a reduced area and severity of impact, and the likelihood of spreading across high plateaus into adjoining valley systems (where communities and property may be at risk) was minimized;
- To reduce the potential for widespread and severe post-fire erosion risks to be created (which can exacerbate flooding risks, topsoil loss, water quality degradation and water storage capacity reduction); and
- To prevent high country landscapes from becoming 'locked-in' to a low to moderate frequency-high intensity/impact fire cycle.
- To reduce the size and frequency of high intensity fires (which are bigger and occur more frequently in the absence of landscape scale grazing and/or burning) thus protecting the high country from catastrophic impacts of megafires

Sub-model 3 - Vegetation/fuel impacts of grazing and burning

Alpine and sub-alpine grasslands:

The effect of seasonal grazing on vegetation and fuel characteristics in alpine and sub-alpine grasslands is to:

- Substantially retard the accumulation of dead grass thatch and dead herbage within the grassland (increasing the proportion of live green matter relative to dead matter);
- Keep the average height of the grassland short – typically not much more than ankle high – whilst providing for variability in height and structure;
- Preventing the development of uniform, high fuel load, senescent state grasslands across broad areas;
- Stabilise the distribution and density of shrubs in the grassland, preventing invasion/increasing site occupation by shrubs (note this was not achieved by grazing alone – burning in conjunction with grazing was important for preventing shrub invasion);
- Promote areas of open, short tussock grassland structure which provide improved growth and reproduction opportunities for herbs and forbs that occupy inter-tussock spaces;
- Maintain general site vegetation structure and conditions to which endemic flora and fauna are adapted and providing fire refugia.

Without either grazing or periodic low intensity burning (intervals of around 4 to 7 years), or a combination of both, tussock grasses such as snow grass grow sufficiently tall and dense (with dead grass thatch from many seasons growth providing the bulk of the biomass) that they crowd and shade out inter-tussock spaces in which a variety of small, low growing native herbs and forbs grow. Without access to light and with diminished access to moisture and nutrients, this inter-tussock biodiversity becomes depleted over time and the tussock grass health and condition declines.

Grazing and burning reduce the height of tussock grasses, and greatly reduce the density of dead grass thatch thus maintaining an open, healthy and vigorous tussock grassland in which the variety of other grassland biodiversity can flourish. Removing low intensity fire from high country grasslands without compensating for fire removal with another mechanism (eg grazing) to prevent widespread and dense accumulations of dead grass thatch will result in negative biodiversity impacts (both for ground cover species and for sub-alpine woodland canopy species which will inevitably be exposed to high intensity fire).

See Panels 1 and 2 on the following page, depicting differences in grassland structure, vigour and diversity with well managed grazing and burning (Panel 1) and with long-term fire and grazing exclusion (Panel 2). See also Figures 1 to 3 showing photos of sub-alpine grasslands subject to different management practices.

Panel 1 - High diversity, high vitality and high resilience grazed tussock grassland. Alpine and sub-alpine grasslands managed with summer grazing and/or periodic low intensity burning are maintained as short (not eaten-out) open clumped grassland with a high diversity of herbaceous plants in the open inter-tussock spaces. Lower fuel quantity with a higher proportion of live green biomass (relative to ungrazed grassland) makes grazing/mild-fire maintained grassland less fire prone in summer, and not able to support a high intensity fire.

Panel 2 - Declining diversity, low vitality and low resilience long-ungrazed and unburnt tussock grassland. Alpine and sub-alpine tussock grasslands which have grazing and low-intensity fire excluded for long periods have inter-tussock spaces crowded and shaded out by dominant grass cover suppressing inter-tussock plant diversity. Grass tussocks senesce and accumulate high quantities of highly flammable dead thatch. Summer fires burning into long-ungrazed/unburnt grassland burn intensely with a long residence time adversely impacting soils and high intensity fire-sensitive inter-tussock vegetation.

Figure 1 Tall dense grass cover at 'Native Cat' grazing exclosure
Note the difference in grass height and density inside the grazing exclosure to outside.

Figure 2 Long-unburnt and ungrazed snow grass tussocks (Snowy Plain, NSW)
Note the dense accumulation of dead fine fuel, and the lack of inter-tussock spaces for inter-tussock species.

Figure 3 Vigorous and diverse native grassland in summer (Snowy Plain, NSW)

Note the lower grass tussock height (relative to ungrazed grass); the high live/green to dead grass proportion, and the presence of inter-tussock plant diversity.

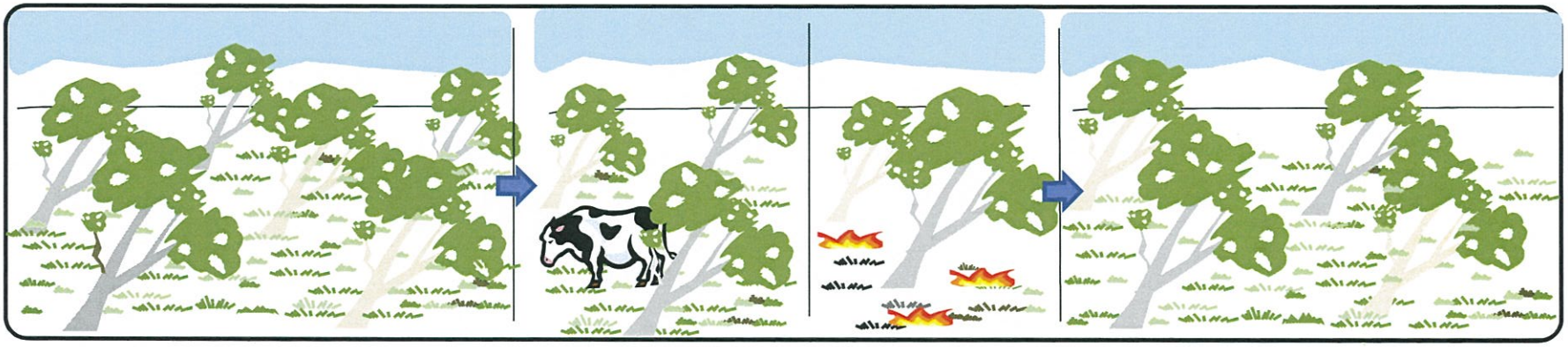
Grassy sub-alpine woodlands and montane forests:

The effect of seasonal grazing on vegetation and fuel characteristics in sub-alpine woodlands is to:

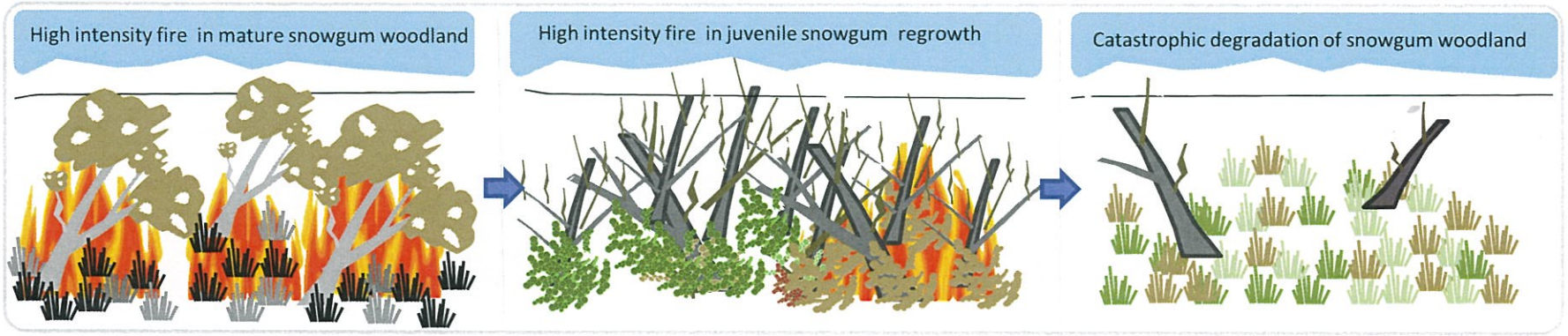
- In the grassy understorey, the effects are as described in the previous section on alpine and sub-alpine grasslands;
- In overstorey woodland trees the effects of seasonal grazing of the understory include:
  - Maintaining favourable site conditions for tree growth (open tussock grass allowing some sunlight to penetrate to inter-tussock spaces, and warming soil temperatures during the day)
  - Maintaining a gap between grass and snow gum canopy (snow gum canopies vary in height but at higher elevations canopy heights can be quite low) by reducing grass height and the action of cattle moving around under trees reducing the accumulations of dead fine branch material in the lower canopy
  - Thinning out emergent seedlings (tree and shrub) such that the widely spaced mature tree characteristics of the woodland are maintained preventing overcrowding and formation of dense regrowth thickets. Over long time periods, enough seedlings survive to provide for replacement of senescing trees as they die

The combination of the above impacts increases the resilience of sub-alpine woodlands to low-moderate intensity summer fire, as the vast majority of woodland trees are mature and in a healthy condition with canopies sufficiently far above the grazed grassland that the low intensity fire it may support in adverse conditions will not have as severe impacts relative to those in ungrazed sub-alpine woodlands. This facilitates ongoing survival of iconic old-growth snow gum woodlands, allowing trees to live a full life span reaching late senescence (as opposed to very large scale destruction of old-growth snow gum woodlands and replacement with vast expanses of young dense regrowth thickets which themselves are at very high risk of destruction by the next high intensity fire, potentially before they reach maturity (replacing natural seed source) and thus at risk of local extinction).

By far the greatest current threat to old-growth sub-alpine woodlands, and juvenile regrowth stands, is large scale high intensity fire. The most effective means of reducing the threat to these iconic old-growth stands across broad areas is grazing and/or low intensity burning. Old-growth sub-alpine woodlands, which as a result of very large high intensity fires occurring in the Victorian high country in 1998, 2003, 2006 and 2009, are now grossly under-represented in conservation reserves. Recent losses of old-growth snowgum woodlands are particularly acute across Howitt plain, the Fainters, the Bogongs, and from Dargo up to Hotham. The greatest single threat to these unique ecosystems is continuation of a land management regime that involves neither grazing nor low intensity burning. Continuation of such a regime will lock the high country into a cycle of recurring high-intensity fire (at much shorter intervals than has occurred historically) with catastrophic consequences for sub-alpine woodland and montane forest ecosystems. This threat is much more significant than climate change, and will be exacerbated by climate change.



Panel 3 - Healthy, fire-resilient old-growth sub-alpine woodland maintained by grazing and/or low intensity burning. Old growth snow gum woodland which has survived and flourished through more than a century of grazing and low-intensity fire can be killed by a single high-intensity fire event. For a high intensity fire to occur, abundant grass and shrub fuel must accumulate in the understorey sufficient to fuel a fire which results in complete canopy scorch. A short, open-clumped grass understorey, maintained by grazing and/or low intensity burning eliminates the potential for high intensity snow gum killing fire within the subalpine woodland.



Panel 4 - Short to moderate interval, high-intensity fire cycles are the most serious threat to sub-alpine woodlands. Fires burning in heavy grass fuels can be of sufficient intensity to kill mature sub-alpine woodland trees across broad areas. Resprouts from lignotubers and regeneration from seed is highly sensitive to fire and has a juvenile period of at least 12 years. A second moderate to high intensity fire can kill young regrowth leading to catastrophic stand degradation and potentially elimination of tree cover and conversion to grassland or shrubland.

Figure 4 Old-growth snow gum woodland with prolific grass understorey

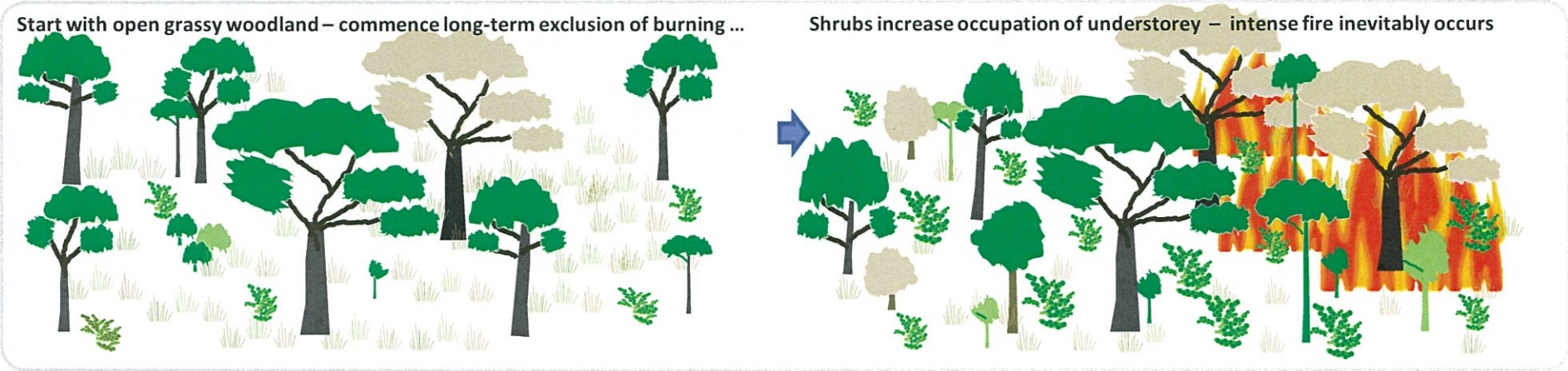
Figure 5 2006 fire-killed snowgum woodlands
Ungrazed grass and shrubs are accumulating under these regenerating snowgum woodlands

Woodlands and dry open forest at elevations below the sub-alpine woodland and montane forest zone:

The effect of seasonal grazing and burning on vegetation and fuel characteristics in lower elevation woodlands and dry forests is:

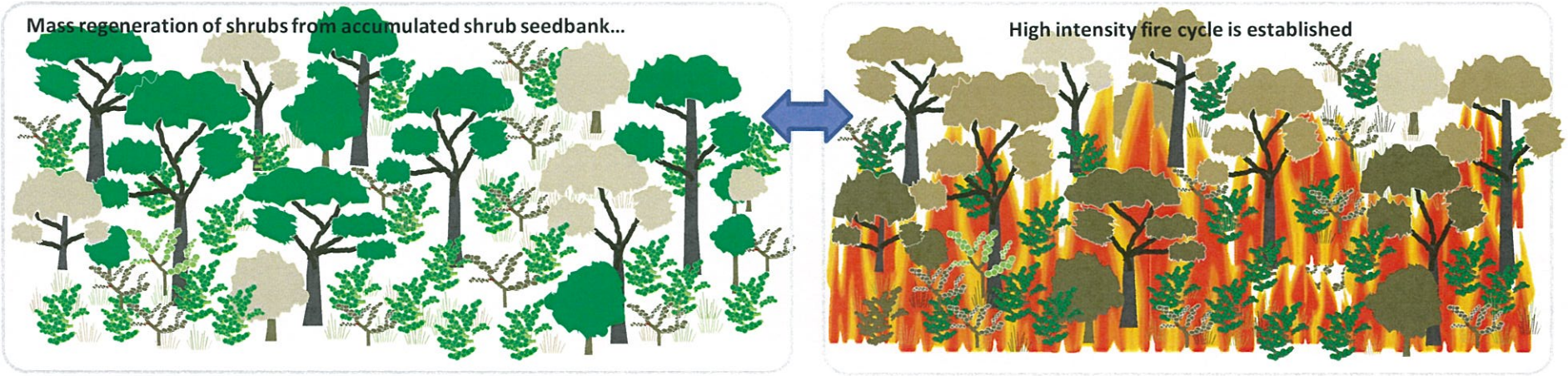
- In the majority of dry Eucalypt woodland/open forest types within current or former high country cattle runs, grazing alone will achieve some reduction in grass height and density. However, these effects become increasingly reduced over time as, without burning, the availability of fresh nutritious grass attractive to cattle reduces and cattle will not remain long enough, or in sufficient numbers in such areas to maintain an effective level of grass fuel reduction (they will move on looking for areas of better feed). Without burning, and with declining grazing, shrubs increase their occupation of the understorey, with grass cover declining further, thus exacerbating the situation;
- In the majority of dry Eucalypt woodland/open forest types within current or former high country cattle runs, low intensity burning on a cycle of 5 to 7 years, in an unbounded mosaic pattern, has the following effects on vegetation and fuel characteristics:
  - Accumulations of rank grass not grazed by cattle are burnt in the burnt patches, but remain in unburnt patches (i.e. they are not uniformly consumed across broad areas)
  - New season growth of grass shoots within burnt patches is promoted providing sources of young green nutritious grass that will attract cattle to graze
  - Small, juvenile shrub seedlings will be killed by low intensity fire in burnt patches, however remain unharmed in unburnt patches, and older, mature low-intensity fire tolerant shrubs remain in both burnt and unburnt patches. The overall effect is to maintain the presence of shrubs as a sparse or patchy presence in the understorey (not to eliminate them), maintaining grass occupation, and preventing increasing shrub proliferation and occupation of the site.
  - Thinning out emergent tree seedlings such that open woodland/forest structure is maintained (preventing woodland/forest thickening), but with sufficient survival that canopy trees are replaced over the long term.
  - Reduction (but not complete removal) in litter fuels on the ground and suspended in low shrubs and grass clumps. This reduction is not uniform (as it often is for high intensity fires) but results in patches of burnt and unburnt ground within the area being burnt;
  - Charring of bark on fine fibrous-barked trees, mostly the lower trunk section, but depending on burning conditions charring may extend further up trunks to lower branches, especially during dry conditions
  - Maintenance of a fuel-gap between understorey fuels and the canopy

See Panels 5 and 6 on the following page, depicting the transition from open woodland with mixed grass shrub understorey to a denser woodland/dry forest with shrub dominated understorey and a high intensity fire cycle.



Panel 5 - Open, high diversity, high fire resilience mixed species woodland. Grazing and/or recurrent low-intensity fires maintain grassy dry sclerophyll woodland and forest in an open condition with healthy grass cover and shrubs present as a sparse or patchy layer. Diversity of fire patchiness and intensity promotes high woodland biodiversity.

Open grassy woodland in transition to shrubby woodland. With ongoing absence of low intensity fire, shrubs and young trees increase their occupation of the understorey, and build up seed banks. Grass declines progressively due to competition from shrubs and trees. Woodland is more prone to high intensity fire.



Panel 6 - High intensity fire cycle established in formerly low intensity fire cycle woodland/forest. High intensity fire promotes prolific shrub regeneration, grassland species presence in the understorey further declines. The altered woodland/forest composition and structure promotes a moderate frequency high-intensity fire cycle (difficult to re-establish low intensity fire).

Figure 6 Long-unburnt mixed species woodland with thickened understorey
This lower elevation woodland (around 500m) near Mt Djoandah is long-unburnt. Shrubs have thickened in the understorey. Summer fire in this woodland is highly likely to involve the shrub layer, with post-fire response being further shrub layer thickening.

Sub-model 4 - Fire behaviour effects of grazing and burning

Alpine and sub-alpine grasslands:

The effect of grassland vegetation structure and fuel characteristics modification, brought about by seasonal grazing, on fire behaviour in alpine and sub-alpine grasslands is to:

- Eliminate the possibility of short grazed, predominantly green grassland areas burning at high intensity (if at all) during summer bushfires. Annually grazed alpine and sub-alpine grasslands (and especially those that also are low-intensity burnt at around 7 years intervals) will be green during the peak of the bushfire season, even during severe droughts (as the few annually grazed sub-alpine grassland areas were in the severe Victorian seasons of 2003, 2006 and 2009).
- Areas which are carrying a low quantity of cured grass (potentially into its second summer without grazing or burning), which are drought and/or heatwave affected, may carry a low intensity, potentially patchy summer fire under adverse fire weather conditions (depending on the degree of grass cover continuity and curing). For such areas to carry fire, fire would need to arrive at the grassland from adjacent woodlands or forests as a vigorous surface fire or massive short distance spotting.
- Areas with between two and three years accumulation of rank grass are likely to carry a flashy, free running grass fire in severe summer conditions, and may also burn at lower intensity in less severe conditions;
- Areas with more than three years accumulation of rank grass are likely to carry a hot running grass fire. Long-unburnt areas with high accumulation of dead grass thatch may burn intensely for significant periods exposing soils to significant levels of radiant heat which can adversely affect soil crusts and inter-tussock herbs and forbs;
- Moderately dense scrub or heath dominated patches within grassland areas are likely to burn at significantly higher intensity than surrounding grassland due to the flammability of the shrubs themselves and the retention of rank grass patches underneath which were protected from grazing by the scrub cover
- Herbaceous plants and orchids become prolific after fire (alpine daisy, trigger plants, everlastings, billy buttons)

Suggestions that fire naturally self-extinguishes when it reaches alpine grasslands, whether they are grazed or not, are incorrect. Fire reaching Howitt plain (elevation around 1800 metres) in the 2006 alpine fires burnt as a free-running grass fire across ungrazed alpine grassland. However, areas of grazed grassland can provide protection to adjacent areas of ungrazed grassland, as fire spread can be stopped at grazed areas, thus preventing the fire from running into ungrazed grass areas.

Figure 7 2003 fire impact at a fenced plot on the Bogong High Plains

Note the high proportion of grassland within the fenced plot which has been burnt – only grass within the shallow moist drainage depression remained unburnt. This contrasts strongly with the grazed grassland outside the fenced plot at which the fire has stopped.

Grassy sub-alpine woodlands and montane forests:

The effect of grassland vegetation structure and fuel characteristics modification, brought about by seasonal grazing, on fire behaviour in grassy sub-alpine woodlands and montane forests is to:

- Eliminate the possibility of short grazed, predominantly green grassland areas burning at high intensity (if at all) during summer bushfires. Annually grazed sub-alpine woodlands (and especially those that also are low-intensity burnt at around 7 year intervals) will typically be green during the peak of the bushfire season, even during severe droughts (as the few annually grazed sub-alpine woodlands were in the severe Victorian seasons of 2003, 2006 and 2009).
- Areas which are carrying a low quantity of cured grass (potentially into its second summer without grazing or burning), which are drought and/or heatwave affected, may carry a low intensity, potentially patchy summer fire under adverse fire weather conditions (depending on the degree of grass cover continuity and curing). For such areas to carry fire, fire would need to arrive at the sub-alpine woodland from adjacent lower elevation mixed species woodlands or forests as a vigorous surface or crown fire or via mass short distance spotting.
- Areas with between two and three years accumulation of rank grass are likely to carry a flashy, freely burning grass fire in severe summer conditions, of sufficient intensity to cause significant mortality and damage to the sub-alpine trees, especially at higher and more exposed elevations in the sub-alpine zone where tree canopies are lower to the ground (as occurred in many areas during the 2006 fires);
- Areas with more than three years accumulation of rank grass are likely to carry a hot running grass fire which is likely to cause tree mortality across extensive areas. Long-unburnt areas with high accumulation of dead grass thatch may burn intensely for significant periods exposing soils to significant levels of radiant heat which can adversely affect soil crusts and inter-tussock herbs and forbs (as occurred across extensive sub-alpine areas in 1998, 2003, and 2006);
- In fire-sensitive grassy montane forests, particularly Alpine Ash stands, annually grazed areas carrying short green grass can significantly reduce the intensity of a fire spreading into the forest from adjacent fire prone woodland or forest. Mature Alpine Ash trees standing over short green grassy understoreys kept open and tramped down by grazing may survive the passage of fire once the fire behaviour emerging out of the adjacent woodland has moderated upon entering the Alpine Ash forest. However, if sufficient cured grass is present to carry a hot running fire of sufficient intensity to ignite for the woolybutt bark and burn up the bark sock, extensive mortality can be expected.

A vitally important fact is that fire intensity within grazed grasslands and grassy woodlands is significantly lower than in ungrazed grasslands. This is self-evident, with the fire intensity reduction effect observed first hand, on numerous occasions by both cattlemen and firefighters. It is supported by accepted scientific theory (according to Byram's equation for fireline intensity, reducing fuel quantity by half

will result in a four-fold reduction in fire intensity). The fire intensity reduction effect is even greater when fuel flammability differences (proportion of live green biomass to dead flammable biomass) and grass fuel height are taken into consideration.

This vitally important factor was omitted from any consideration in a recent study (a study upon which the findings of government inquiries and policy decisions have relied heavily) examining the extent to which grazing reduces fire impact in alpine and sub-alpine areas. A comparative study of fire impact in grazed and ungrazed alpine areas following the 2003 fires (Williams et al 2006) inexplicably only examined fire intensity in alpine heathlands. Given that the authors of the study concede that 'grazing does not appear to affect the abundance of the taller, shrubby fuels, and indeed there is no obvious mechanism by which cattle could substantially reduce the abundance of such fuels in heathy communities' cattlemen consider it astonishing that they only chose to examine fire intensity in those alpine vegetation communities where grazing has negligible impact. Williams et al (2006) devised a research methodology which avoided assessing fire intensity in grassy ecosystems (eg. sub-alpine woodland) in which grazing has the greatest fuel reduction impact.

With respect to fire occurrence differences in grazed and ungrazed grasslands, the line transect methodology used is highly sub-optimal, particularly given the large landscape area of the sampling area (>200 square kilometres) and the relatively small number of grassland points sampled (only 113). Spatial analysis using remote sensing technologies, readily available at the time, is far superior for determining patterns of burning. The researchers indirectly acknowledge their methodology deficiency issue in their statement that 'Further research is warranted on the patterns of burning on the Bogong High Plains and other high alpine/subalpine areas of Victoria and new South Wales. Air photos and other remote sensing images (e.g. Landsat) were acquired immediately post fire, and are available for analyses of spatial patterns and severity…'. Figures 13 and 14 show actual burning patterns on the Bogong High Plain as directly observed using Landsat satellite imagery (accessed through DSE's Forest Explorer system via its public website). The burning patterns seen appear to be very different from the statistical results described by Williams et al (2006) as derived from their line transect ground sampling.

Therefore, cattlemen consider that the researchers' key conclusion that 'the use of livestock grazing in Australian alpine environments as a fire abatement practice is not justified on scientific grounds' (a conclusion heavily relied upon by Victoria's Alpine Grazing Taskforce) is tricky and misleading. It is not clear whether it means that the body of scientific research is insufficient to justify a conclusion that grazing is an effective fire abatement practice, or whether it is meant that there is sufficient scientific evidence to justify a conclusion that grazing is not an effective fire mitigation practice in alpine environments.

A more correctly stated finding would be that there is insufficient scientific evidence to form a reliable conclusion either way as to whether grazing reduces blazing. The study itself should only be entitled to claim scientific evidence for a lack of statistical difference in fire occurrence and intensity between ungrazed areas, and the ungrazed components of closed and open heath within grazed areas (which is hardly surprising since cattle largely avoid grazing those vegetation types).

This study was so seriously flawed in its design, and its conclusions are so misleading that MCAV consider it is of no value other than confirming that alpine shrubs burn intensely during severe fires.

To evaluate how grazing reduces fire intensity, it is common sense that studies need to examine the vegetation types in which grazing is most prevalent. A far more useful and valid approach to examining fire behaviour differences between grazed and ungrazed areas would have been to examine fire behaviour differences between grazed and ungrazed sub-alpine woodlands where fire behaviour is dominated by grass fuel, and therefore where grazing can and does have an impact. This can be done by examining the extent and severity of canopy scorch, and rates of tree mortality in grassy snow gum woodlands. Degree of crown scorch and tree mortality is commonly used in post-fire impact assessment in Eucalypt dominated forest and woodlands. Use of remote sensing technology has been applied and proven effective in this application and is far superior to spatial extrapolation from a small number of line transects with limited sampling points. Such a study could still be done today, despite the passage of time since fires, by accessing and analysing readily available remotely sensed imagery (before and after) of fire impacted areas.

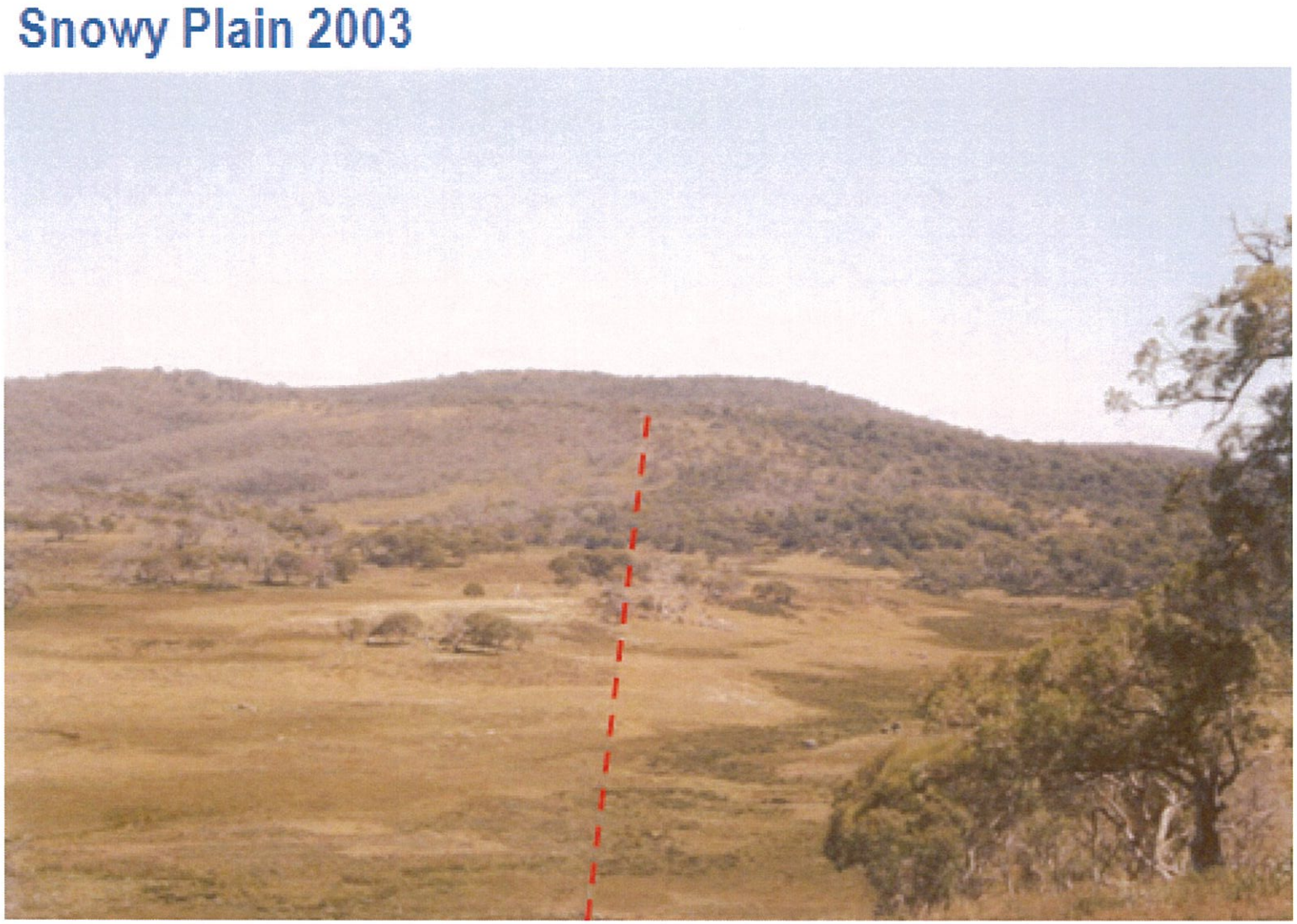


Figure 8 Area of Snowy Plain burnt during the 2003 fires
On the left of the fenceline (highlighted using red dashed line) is a conservation reserve in which grazing and burning are prohibited, extensive tracts of dead snow gum can be seen. On the right which is private property used for cattle grazing, the snow gums have survived with canopies are intact.

Figure 9 2006/07 Raspberry Hill (Bogong High Plains) fire impact either side of a fenceline

Note how this snowgum woodland fire has stopped abruptly at the fenceline. Where annual grazing has been maintained (right side of fence), grass was short and green halting fire spread. On the left side of the fence, grazing had ceased in 2005 – in just two growing seasons sufficient grass had accumulated to fuel a fire of sufficient intensity to cause extensive canopy scorch in mature snowgums which are now resprouting from epicormic buds on those sections of their branches that were exposed to lower levels of radiant heat. In 2003, fires petered out when they reached grazed areas of the Bogong High Plains, whereas in 2006 after grazing had been ceased for 2 seasons, fire spread across areas previously protected by grazing causing extensive mortality and damage.

Figure 10 Fire-killed old growth snowgum

Extensive tracts of old-growth snowgum woodlands near King Billy Hut were killed by high intensity fire in 2006. These woodlands were previously protected from fire by grazing which kept the grassy understorey short and green. Abundant regeneration can be seen which will remain in a highly fire vulnerable juvenile state for up 20 years. Prolific rank grass accumulation can be seen amongst the fire-vulnerable snowgum regeneration. A serious, current and long-persisting threat to this landscape is the loss of the snowgum woodlands which can be brought about by a single grassfire which spread quickly covering large areas in a short space of time. The only viable protection for the snowgum regeneration is grazing to create a short green grassy understorey which cannot carry a fire.

Figure 11 Cattle grazing in a trial site

The short green grass in this trial site will not support a fire.

Figure 12 Ancient old-growth snowgum (King Billy Tree)

This ancient old-growth snowgum has survived for centuries, including through dozens of droughts and severe fire seasons. In pre-European settlement times it was protected by a fire regime consisting of unrestrained lightning fires and Aboriginal burning. Since pioneer cattlemen brought cattle to the snowgum woodlands more than 150 years ago, it has been protected by grazing. It has survived many low intensity fires throughout its long lifespan - none have been sufficiently intense to kill it due to the low grassy fuels maintained by pre and European settlement land management practices. With grazing now excluded from this area (with grass now accumulating as can be seen), no low intensity burning, and continuing lightning fire suppression across the landscape, this magnificent ancient tree and many more like it are at historically unprecedented risk of being killed by fire.

Woodlands and dry open forest at elevations below the sub-alpine woodland and montane forest zone:

The effect of vegetation and fuel characteristics modification, associated with seasonal grazing and burning, on fire behaviour in lower elevation woodlands and dry forests is to:

- In the majority of dry Eucalypt woodland/open forest types within current or former high country cattle runs, areas which have been grazed only (most areas due to license conditions prohibiting burning) will not have a significant difference in fire behaviour relative to similar ungrazed areas. This is because in the prolonged absence of burning reduces grazing value significantly, with the result that bush run areas get sparsely grazed if at all, with shrub cover and density increasing such that the fuel characteristics and hence fire behaviour are little different from ungrazed areas.
- In dry Eucalypt woodland/open forest types within current or former high country cattle runs, grazed annually and burnt at low intensity on a cycle of 5 to 7 years, the following fire behaviour can be expected:
  - During extreme weather in drought years, fire may still spread through these areas, burning through the older fuels within the mosaic and readily spotting across very low fuel areas. However, the fire intensity and rate of spread will be significantly lower than in ungrazed and unburnt areas where very severe fire behaviour can be expected.
  - During typical summer conditions (not adverse weather in the extreme or very high range) bushfires spreading into grazed and burnt cattle runs will typically burn as a surface fire, being more vigorous in heavier fuel patches, and on upslope runs, and spreading slowly as a low intensity surface fire on down hill runs and lower fuel areas.
  - During autumn or spring, bushfires spreading into grazed and burnt cattle runs will typically burn as a low intensity fire, achieving results not dissimilar from prescriptions used in hazard reduction burning. Fires are typically patchy, and if winds get up can escalate in behaviour, but vigorous burning is likely to only be for a 2 to 3 hour period.

- In dry Eucalypt woodland/open forest types of the mountains where grazing is excluded and which are long-unburnt (typically around 7 to 8 years in ungrazed woodland/forest is sufficient time for high to very high fuel hazard to accumulate) bushfires burning on severe fire weather days will exhibit extreme fire behaviour over broad areas (as occurred in 1998, 2003, and 2006). During less severe fire weather, such as that typically occurring on average summer days, bushfires burning in long-unburnt dry forests and mixed species woodlands can burn for extended periods of time remaining alight until weather fronts bring elevated fire danger bringing about further high intensity fires. Large bushfires burning in dry mixed species mountain forests and woodlands with heavy fuels are very difficult to contain and may burn for weeks or months. When large high intensity fires make high intensity runs in mountain terrain, long distance spotting can occur as fire travels up steeply slopes through montane forests. This can spread fires across major ridge systems to adjacent valleys.

Fire behaviour - landscape level overview

At the landscape level, the effect of traditional high country grazing practices is to reduce grass fuel height, quantity and flammability (increase greenness during summer) throughout the alpine/sub-alpine grasslands, grassy sub-alpine woodlands and grassy montane forest areas within grazing runs. This results in less sub-alpine woodland, grassy montane forest, and alpine grassland being burnt during severe summer bushfires due to the lower rates of spread in the reduced fuels.

Where there is good landscape scale connectivity of grazed alpine and sub-alpine systems along major topographic features (eg. high plateaus and broad ridges) where grass is short and mostly green, fire spread can peter out at these open grazed areas preventing the spread of bushfire to adjacent valleys to the east and south, thus reducing significantly the extent of area burnt. For example when traditional grazing practices were occurring there, summer fires never crossed the divide between the Howqua and Macalister valley systems.

In 2003, when extensive fires burnt a high proportion of the Victorian Alps at high intensity, fire petered out when it reached grazed areas on the Bogong High Plain.

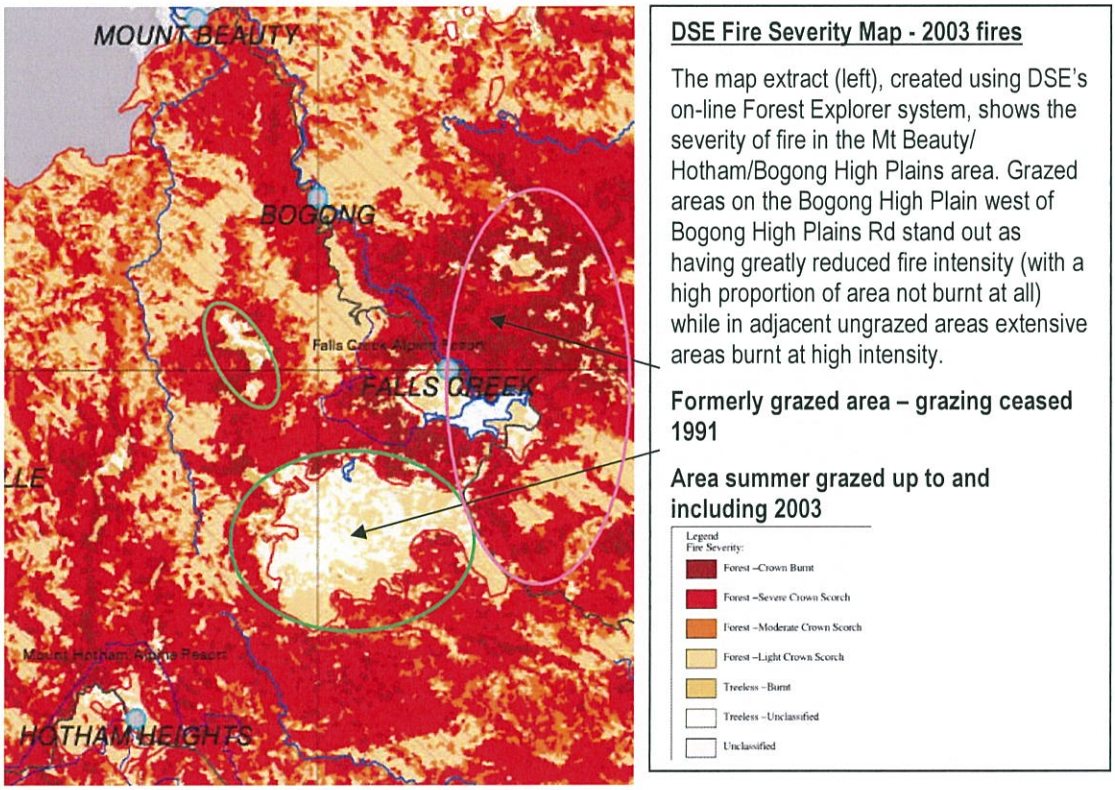
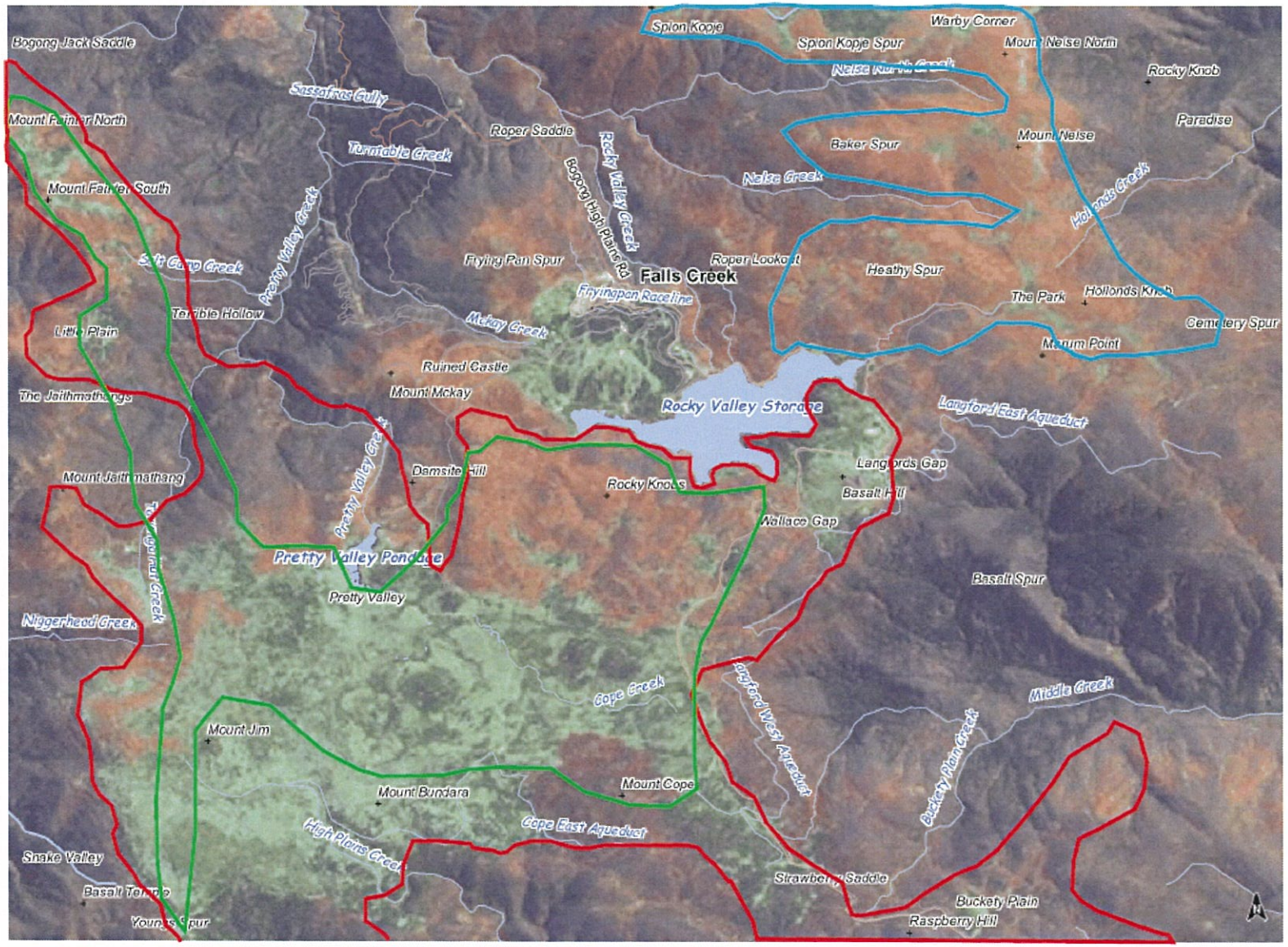


Figure 13 2003 Fire Severity Map – Bogong High Plains area

The broad grazed grassy plateau area of the Bogong High Plain remained largely unburnt. Despite high intensity upslope fire runs burning approaching from the west and the south, cattlemen and their cattle remained safe on their runs on the south Bogong High Plain and on Mt Fainter. By contrast, north of Bogong High Plains Road, where grazing leases had been terminated since 1991, fire severity mapping shows intensity was much more severe, with only isolated green patches in drainage depressions remaining unburnt.

Bogong High Plains - Post - 2003 fire satellite image (Landsat)



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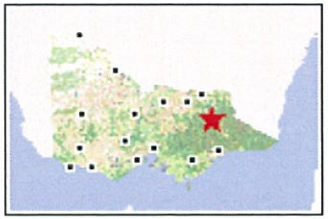

ROADS
- Freeway
- Highway
- Main Road
- Secondary Road
- Local Road
- 2WD (Unsealed)

WATERCOURSES
- Major Watercourse
- Minor Watercourse

WATERBODIES
- Watercourse Area
- Permanent Waterbody
- Wetland Area

BUILT UP AREAS

Area bounded by red is approximate grazed area. Grazing in closed heath sections is negligible.

Area bounded by green is area within which Williams et al's 'grazed' transects were located

Area bounded by blue is area within which Williams et al's 'ungrazed' transects were located

The satellite image shows patterns of fire extent and intensity. Unburnt and very low intensity burnt areas (green) make up a high proportion of the grazed area. High intensity burnt areas (brown and black) make up a very high proportion of the ungrazed area - green patches are very small.

Figure 15 Bogong High Plains following the 2003 fires
View west across Bogong High Plain towards Mt Jim in the distance. The area burnt was on land from which cattle had been excluded for about 10 years. The sharp fire edges are the boundary fence between grazed and ungrazed land. The fire has gone out at the grazed boundary and the adjacent grazed expanse of the Bogong High Plains has been saved from devastating fire by the grazing of cattle. As can be seen, snow gum woodlands and flammable heaths within the grazed plateau area remain unburnt.

Expanses of old growth high alpine and subalpine woodlands and heaths such as these are now rare in the Victorian Alps.

In lower elevation mixed species Eucalypt woodlands and dry forests, where grass cover is more patchy, with a greater proportion of shrubs in the understorey, and having higher quantities of Eucalypt litter, the impact of grazing on fuels is less pronounced. In these areas, burning at intervals of 4 to 8 years is required to prevent shrub cover increases, forest litter accumulation, and maintain grass vigour. Fire behaviour at these lower elevations is reduced in all conditions, however high intensity fire can still be supported during severe weather conditions. When fire weather conditions moderate, the lower fuels and more open structure of the understorey supports lower rates of fire spread, and therefore the extent of fire is less than what it would otherwise be when severe weather conditions return. The overall result is that in grazed and low-intensity burning treated woodlands and dry forests, the extent of severely burnt areas is less than in ungrazed areas with no low intensity burning. Further, fire spread patterns in those areas burnt outside of the peak fire weather conditions are patchier, with reduced consequences for erosion and flora/fauna survival and post-fire recolonisation.

Sub-model 5 - Landscape bushfire risk reduction effects of grazing and burning

Landscape bushfire risk reduction:

At the landscape scale, the effect of high country grazing and traditional burning practices is to reduce the risk of large scale high intensity fires (megafires). Risk is a function of likelihood and consequence. Landscape bushfire risk reduction by high country grazing and burning is achieved by reducing both the likelihood of such fires and their consequences.

Reducing the likelihood of very large, high intensity fire events (megafires):

Likelihood of high country fire ignition and spread

A major source of summer fires in Victoria's remote high country areas is from lightning strikes. Lightning was the chief source of major high country fires in 2003 and 2006 and 2009. Systematically reducing fuels and modifying their condition (eg. shorter greener grassy understoreys) in sub-alpine woodlands and lower elevation woodlands and dry forests reduces the likelihood that lightning will strike areas receptive to starting fires. Lightning strike fires start as point ignitions - usually a lightning struck tree. To become a spreading fire (not just a partially burnt tree or branch) there must be sufficient ground fuel in a combustible condition extending from the tree to fuel the spread of fire.

When grazing is undertaken annually in sub-alpine woodlands, low fuel grass understoreys under trees are typically short and green. Point ignitions such as lightning struck trees therefore do not find fire prone fuel to spread through, and burn out as a small fire in a dead seasoned section of the tree trunk or branch. However, in sub-alpine woodlands where grazing is excluded and no low intensity burning is conducted, rank grass accumulates forming a taller, denser and more flammable fuel bed. Cured grasslands are among the most flammable of vegetation types. When lightning strikes a tree with prolific, cured flammable grass underneath there is a much higher likelihood of a fire starting and spreading from the ignition point, than in areas where grass is green and short.

Conclusion: Grazing and burning reduces the proportion of lightning strikes that start fire.

The likelihood that a fire will become large and intense

Once a fire is ignited, the likelihood that it will become large and intense is a function of four key variables:

1. Fuels: The extent of a bushfire prone area (how large an area the fire prone fuel covers) limits the size a fire can achieve, and the quantity/arrangement and moisture content of fuel limits the rate at which a fire can spread and how intense it can be. Therefore, large expanses of heavy fuel can generate larger and more intense fires than smaller areas with less fuel.
2. Weather: weather influences both the rates of spread and intensity of a fire The severity of weather that that prevails and the duration of the severe weather will strongly influence the size a fire can grow to and its intensity (subject to the fuel constraints).
3. Topography: The slope of land on which a fire is burning influences both rate of spread in intensity. Up-slopes increase rate of spread and intensity, down-slopes reduce them.
4. Suppression capacity and success: Human efforts to contain and extinguish fires can limit the extent that a fire spreads. The degree to which suppression can be effective in limiting the size of a fire is heavily influenced by both the rate of spread and intensity of the fire, as well as other capacity constraints including access to suitable places in the landscape from which to safely conduct containment and suppression, the strength, type, location and proficiency of suppression resources.

Weather and topography are not factors that can be controlled. Being strongly limited by prevailing fire behaviour, fire suppression success has a dependency on fuel factors. The more fuel available to a fire, the higher its rate of spread and intensity will be, and therefore the more difficult it will be to contain. Limiting thresholds for fire behaviour upon suppression success are relatively low (bushfires can exceed the limits of human fire suppression capacity at a relatively low proportion of their possible intensity range). Human fire suppression effectiveness is at its greatest when fire spread rates and intensity are at the very lower end of their possible range.

Therefore, for fires starting under a given set of weather, topographic and fire suppression capacity conditions, the critical factor determining how large and intense the fire can get is fuel quantity and condition. In grazed and low intensity burn treated landscapes, fuels in recently grazed areas and in recently burnt areas can be significantly lower than in ungrazed and unburnt areas. In the case of grass fuels, cyclic grazing and/or burning has the effect of keeping a much higher proportion of grass live, green and in a low flammability condition than in ungrazed/unburnt areas. When the availability of lower and less flammable fuel areas in the landscape covers a significant proportion of the landscape, then the size that a fire can achieve in prevailing conditions is significantly reduced as is the intensity (relative to an area with no grazing or burning treatment). Lowering fire rates of spread and intensity has the additional benefit of improving the likelihood of suppression success.

Therefore, grazing and burning significantly reduce the likelihood that a fire under given weather conditions and topography will become a large intense fire, relative to the case for ungrazed and unburnt landscapes. This principle is widely accepted and understood, and underpins the fire risk management practice of fuel reduction which is accepted and conducted in every State/Territory of Australia, and indeed in all fire prone continents on earth.

An instructive example of how grazing can reduce the size and occurrence of bushfires can be found in the semi-arid rangelands of western Victoria and New South Wales. Although these semi-arid landscapes have obvious differences from Victoria's high country landscapes, they have a key similarity that being that grass is the primary fuel in the grasslands and grassy woodlands of both environments.

Across the semi-arid grasslands and open grassy woodlands, grazing is widely practiced. Over many decades, the widespread annual reduction in grass fuel across these semi-arid landscapes has resulted in large fires being very rare. This is despite the fact that locally prevailing climatic condition are highly conducive to fire (much more so than the high country which has a much milder climate). As a result of extensive grazing, the only times that large fires occur in grazed semi-arid landscapes is when well above average rainfall triggers prolific grass growth in a quantity that cannot be grazed down in one season, and when subsequently the grass cures, very large landscape scale fires can and have resulted.

The principles of this grazing and bushfire cycle in semi-arid lands has strong parallels with high country landscapes – if the dominant fuel grass is grazed on a broad scale, large scale fires are greatly reduced, however, if conditions of widespread cured grass are created, very large intense landscape scale fires only need ignition (eg lightning) and adverse fire weather to occur. Given that both lightning and adverse fire weather are certain to continue occurring in Victoria's high country, if avoidance of large scale destructive bushfires is a desired goal, then reduction of grass fuels across broad landscapes is a necessity. This is most effectively and economically achieved by grazing and burning.

Given the very high proportion of old-growth sub-alpine woodlands and montane forests in Victoria's high country that have been killed by a very short-interval succession of large, high intensity and impact fires (1998, 2003, 2006, 2009) and are currently in a highly fire vulnerable juvenile regrowth state, the need for managing grass fuels in these vulnerable woodlands and montane forests is paramount or further fires may see tree cover lost or severely degraded.

Conclusion: Grazing and burning reduces the proportion of bushfires that grow to become large high intensity fires.

Summer fire consequence reduction for moderate-intensity fire sensitive sub-alpine woodlands

Canopy tree species in sub-alpine woodlands and some grassy montane forest types are sensitive to moderate to high intensity fires such as those burning in tall and/or dense grassy fuels. Such fires readily kill adult trees which, unlike many lower elevation Eucalypt species, are adapted to survive low intensity fire only. While sub-alpine Eucalypt species do have epicormic strands beneath their bark from which they can resprout and regenerate their canopy, their bark is much thinner than lower elevation species and therefore cambium death can occur at significantly lower fire intensity. Low intensity fires however, such as those that burn in short, partially cured grass (maintained that way by grazing and/or burning) will not kill most adult trees. Hence in sub-alpine landscapes that have grazing and /or low intensity burning occurring across significant areas reducing the extent of high intensity fire occurrence, there will be a wider variety of woodland ages, including old-growth stands which have survived in the landscape without experiencing fires of sufficient intensity to kill them.

By contrast, in sub-alpine woodland landscapes where neither grazing nor low-intensity fires prevent accumulation of high grass/shrub fuels (such as in areas where grazing is excluded, fire suppression is routinely practiced, and low intensity burning is negligible or on a very small scale) large high intensity fires that kill old-growth woodlands can be expected (and have been experienced at frequent intervals since 1998). The result is much lower seral stage diversity in sub-alpine woodlands, including significant under-representation of old-growth stands, and a high proportion area in juvenile regrowth stages highly vulnerable to fire with local extinctions or severe stand density degradation a significant risk.

Conclusion: Grazing and low intensity burning within and adjacent to sub-alpine woodlands reduces the risk of severe, potentially irreversible damage by fire, making these higher-sensitivity woodlands more resilient to summer fires.

Reduction in the consequences of summer fires on soil erosion and water quality degradation and flooding impacts

Large, very hot fires which kill tree canopies, remove ground cover vegetation which holds surface soil horizons in place, and induces soil hydrophobicity in some soil types, create situations where very high consequence erosion, flash flooding and water quality/storage capacity reduction can occur (eg. at Licola on the Macalister River following the 2006 Alpine Fires). Annual grazing and a low-intensity burning regime reduces the extent and intensity of summer fire events thereby reducing the extent and severity of soil erosion and water catchment value degradation.

The cumulative consequences of well managed grazing and low-intensity burning programs is far less than the consequences of catastrophic large scale high intensity fire events that will continue to occur, potentially at unprecedented frequency if grazing and low intensity burning are excluded or restricted to insignificant proportions of the high country landscape.

Conclusion: Grazing and low intensity burning across a significant proportion of high country landscapes reduces the soil erosion and water catchment consequences of summer fires and reduces the risk of severe consequence erosion, flooding and storage capacity reduction events occurring.

Opportunities for control of unplanned summer bushfires

Significant reductions in the quantity and flammability of grass fuels in alpine/sub-alpine grasslands and grassy woodlands reduces fire intensity and rate of fire spread. Even under adverse fire weather conditions, when bushfires arrive at short grazed open clumped green grassed areas, flame fronts are restricted from spreading - continued fire propagation across such areas is by wind-borne embers only. In more patchily/selectively grazed and low-intensity burnt woodlands where sufficient ground fuel remains to carry a surface fire, the fire rate of spread and intensity will be slower and lower than for similar areas where there has been no grazing or burning.

These fuel reduced areas in the landscape, if they are of adequate extent and aligned with access trails, can provide areas where fire behaviour moderation can assist fire control efforts. Low fuel/flammability areas in alpine vegetation communities and sub-alpine woodlands oriented across summer fire paths can contain the passage of fire across high tops into adjacent valleys when fire behaviour moderates (fire may

spot-over these areas during the short periods of time fires are making high-intensity runs in adverse weather). Low fuel/flammability areas in alpine vegetation communities and sub-alpine woodlands oriented parallel to summer fire paths can provide areas from which flank fires can be contained by bringing fire out to low fuel areas or control lines. More intensively grazed areas that are short and green (such as large holding paddocks) can provide safety zones and anchor points for fire suppression operations. Low fuel/flammability areas enhance fire control options and can assist fire and land managers to reduce the area burnt by summer bushfires.

Conclusion: Grazing and low intensity burning across a significant proportion of high country landscapes improves fire containment options and effectiveness which can significantly reduce fire impacted area.

Reducing catastrophic high intensity summer fire consequences on fire sensitive ecosystems

A number of alpine and sub-alpine ecosystems exist in edaphic situations that protect them from fires (eg. alpine/sub-alpine peatbogs/mossbeds). Accumulation of flammable fuels adjacent to these fire-intolerant ecosystems can significantly reduce levels of edaphic protection. In the case of alpine/sub-alpine bogs/mossbeds, as a result of the drainage features of their landscape position soils are typically saturated/moist and vegetation cover resistant to ignition by moderate to long distance spotting. However, if fuels in adjacent grasslands and woodlands are heavy and in a sufficiently flammable state to support a vigorous surface fire, fires can propagate into the dryer margins of these features, igniting peat and dry sphagnum moss domes and spreading through marginally flammable groundcover vegetation. Where flammable grass and shrub fuels are grazed or burnt at low intensity in areas surrounding fire sensitive peat-bogs, running summer surface fires can be prevented from reaching these fire sensitive locations.

Conclusion: The effectiveness of natural edaphic protection of fire sensitive ecosystems such as alpine/sub-alpine peat bogs /mossbeds is maintained by grazing in surrounding grassland/woodland and is weakened by exclusion of grazing.

Important Note:

For landscape scale risk reduction benefits to be realised, alignment and distribution of grazing runs along a large extent of ridge/ plateau systems is required. Small scale piecemeal grazing can only achieve small scale localised risk reduction and cannot achieve broader landscape scale benefits. Grazing without burning will significantly limit effectiveness.

Figure 16 Severe erosion impact and risk at Watchbed Creek

Figure 17 Repaired road wash-out on Macalister River

Following the 2006 fires, a major rainfall event in the Macalister River catchment caused major damage to roads and resulted in unprecedented flood damage in Licola

References:

Note: The purpose of and scope of works for developing this conceptual model was not to review literature, but to capture inter-generational knowledge from mountain cattlemen describing the nature of their grazing and burning activities and how these affect vegetation, fuels, fire behaviour and bushfire risk. However, in the course of conducting consultations, MCAV requested two reference documents be checked to verify information discussed in relation to historical stocking numbers, and the diet of cattle in sub-alpine environments. The references used were:

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