Mitigating the Impact of Fire on Alpine Peatlands

Final Report

Australian Government | National Landcare Programme | West Gippsland Catchment Management Authority | East Gippsland Catchment Management Authority | North East Catchment Management Authority | Parks Victoria | Victoria State Government

TABLE OF CONTENTS

ABOUT THE ALPINE PEATLANDS FIRE RISK MITIGATION PLANNING PROJECT

The Alpine Peatlands Fire Risk Mitigation Planning Project is an initiative of the Australian Government's National Landcare Program. The objective of the project is to improve the management of Alpine Peatlands in Eastern Victoria, by reducing the impacts of fire and fire control activities. The project has been developed and implemented in five stages with the sixth and final stage yet to be completed. The stages are:

- **Stage 1 Determine the factors that influence susceptibility, flammability and fire intensity.** Key factors have been determined from analysis of impact of fire on Alpine Peatlands from the 2003 and 2006/07 alpine fires (UTAS 2015) (Refer Appendix 5).
- **Stage 2: Prioritising Alpine Peatlands.** Alpine Peatlands clusters have been analysed and prioritised based on their vulnerability and values, into 10 classes and 4 key categories using the MCAS-S decision support tool (UTAS 2015) (Refer Appendix 5).
- **Stage 3 : Determine the impact of fuel reduction burning:** Phoenix fire spread modelling was used to identify the effect of fuel modification strategies on the likely impact of bushfire on alpine peatlands (NSA 2015) (Refer Appendix 6).
- **Stage 4: Develop bushfire response suppression strategies and tactics:** Modelled bushfire scenarios were used to and identify potential bushfire response suppression strategies and tactics for mitigating the impact of bushfire on Alpine Peatlands through workshops with experts from a range of key fire roles (Refer Appendix 7).
- **Stage 5: Bringing it together:** A Guide "Response to Bushfire in Alpine Peatlands; a Guideline for Incident Management Teams" and a Work Instruction "Management of Alpine Peatlands Values during Fire Response" have been produced and are being institutionalised within the Office of the DELWP Chief Fire Officer. (Refer Appendix 4 for Work Instruction Decision Tree). A map layer of Alpine Peatlands and their priority status has been loaded onto Fireweb though eMap (Refer Figure 2). Bushfire Risk Landscape Teams have been considering and implementing proposed planned burning strategies from Stage 3.
- **Stage 6: Roll Out:** This final stage will be implemented over 2016-2018 where the Work Instruction and Guideline will be approved, training will be carried out targeting a wide range of fire roles and procedures will be tested and reviewed should actual bushfires threaten Alpine Peatlands.

The purpose of this report is to summarise the outcomes of stages one to five of the project. The report is in two Parts:

- **Part 1** provides background on the status and values of Alpine Peatlands and the impact of bushfire. The vulnerability of Alpine Peatlands to fire is discussed and prioritisation of their importance to protect from fire is presented.
- **Part 2** The outcomes, outputs and recommendations of the project are presented in alignment with the seven functions of the Code of Practice for Bushfire Management on Public Land (DSE 2012). The response section summarises the discussions of 4 workshops that were held with experienced Parks Victoria, Department of Environment, Land, Water and Planning (DELWP) and Alpine Resort staff in Eastern Victoria. Suggestions of further investigation and research are presented.

PART 1: BACKGROUND

ALPINE PEATLAND VALUES

Alpine Peatlands are mosaic of alpine and subalpine ecological vegetation communities occurring in moist areas at elevations above 1000 MASL where *Sphagnum Moss* is typically present. They are found in swamps, bogs, depressions, alongside streams and pools and on wet slopes usually in treeless areas. The Alpine Sphagnum Bogs and Associated Fens ecological community (Alpine Peatlands) is listed as threatened under the Commonwealth Environment Protection and Biodiversity Conservation Act (1999).

Two components of the ecological community have been listed as threatened under Victoria's Flora and Fauna Guarantee Act 1988 (FFG Act). These are the 'Alpine Bog Community' and the 'Fen (Bog Pool) Community'. The '*Psychrophila introloba* Herbland Community' (listed as *Caltha introloba*), also listed under the FFG Act, may also be found within or abutting *Sphagnum* bogs, particularly around areas of late-lying snow (Department of the Environment 2015).

The ecological community was listed as endangered under the EPBC Act in January 2009, (DEWHA 2009) due to:

- its small geographic distribution coupled with demonstrable threats;
- the continued decline of functionally important species; and
- the severe reduction in community integrity across its range.

The Alpine Sphagnum Bogs and Associated Fens ecological community is a mosaic of alpine and subalpine vegetation communities with close hydrological and ecological connections. The community is typically underlain by deep and extensive organic peat soils that have formed over thousands of years. The characteristics and values of Alpine Peatlands have been documented in the Alpine Sphagnum Bogs and Associated Fens Recovery Plan (Department of the Environment 2015) and the Nationally Threatened Species Ecological Communities Guideline: Alpine Sphagnum Bogs and Associated Fens (DEWHA 2009).

They include:

- Significant habitat for a number of endemic and threatened flora and fauna species;
- Significant water-holding capacity of *Sphagnum* vegetation and the underlying peat, modulating water flow and maintaining the hydrology of surrounding environments. The manner in which bog and fen communities gradually release water from the spring snow melt is critical to the survival of numerous other ecological communities; and
- Intact stands of *Sphagnum* also act as a natural filter for nutrients, pathogens and sediments, thus playing an important role in maintaining water quality throughout catchments, (although research has suggested this function is more localised than at a catchment scale).(Western et al 2009).

Alpine Peatlands have highly significant environmental values, as demonstrated by their National and State legislative status and protection. It is therefore vital that actions are taken to protect them from impacts that may lead to a deterioration of condition or impede them achieving optimum condition. The consequence of disturbance is that recovery to optimum condition is extremely slow and in the meantime they are vulnerable to other disturbances such as erosion and weeds.

The current condition and function of many peatlands is negatively affected by the single or combined impacts of fire (frequency and intensity), weeds, pest animals and infrastructure (Department of the Environment 2015). Such impacts reduce the resilience of the peatlands ecosystem to withstand disturbances and maintain regeneration capacity. The condition and natural resilience of alpine peatlands will need to be optimal to cope with the predicted impacts of climate change, which are likely to bring substantially higher temperatures and reduced rainfall to the alps (DEWHA 2009).

IMPACT OF FIRE ON ALPINE PEATLANDS

The National Recovery Plan for the Alpine Sphagnum Bogs and Associated Fens (Department of the Environment 2015) notes that frequent fire remains an on-going threat to this ecological community, particularly under drought conditions. Frequent fire occurs when the time interval between fires is less than the tolerable fire interval (TFI) , which is 40 years if peat is not burnt and 90 years if peat is burnt (Cheal 2010). The effects of frequent fire can be observed and has been studied in places such as Mount Buffalo National Park (Coates 2010) . Frequent fire may cause permanent damage to peatlands, altering their structure and initiating hydrological changes that affect the way water flows through the peatland, affecting the patterns of moisture and saturation. This may lead to a change in ecological state.

Peat (organic) soil has a high carbon content and can burn under low moisture conditions. Once ignited by the presence of a heat source (e.g., a bushfire penetrating the subsurface), it smoulders. These smouldering fires can burn for very long periods of time, creeping through the underground peat layer. The hydrological impacts of fire on peatlands include a general reduction in water holding ability with an increase in discharge rates and sediment load and the removal of natural vegetation dams, which opens up drainage lines allowing increased flow and erosion and lowering of the water table. Fire may also make the ecological community more susceptible to weed invasion, as shown by the proliferation of willows in peatlands after the 2003 Alpine Fire.

Significant areas of Alpine Peatland were burnt in the landscape scale alpine fires of 2003 and 2006/07 where combined, over two million hectares were fire affected across a range of biomes. In 2003, large areas of Alpine Peatland were also burnt in NSW and the ACT. These fires followed drought conditions in the Australian Alps where inherent moisture levels of alpine wetlands were low, leading to sphagnum and peat soils being able to more readily ignite and burn. The intensity created by the trajectory of large fire fronts coming upslope into alpine areas gaining momentum from some distance away also influenced the burning of Alpine Peatlands.

This project has provided the opportunity to test these observations by carefully studying the factors that influenced the percentage of Sphagnum burnt in Alpine Peatlands in the 2003 and 2006/07alpine fires.

THE FACTORS THAT INFLUENCE SUSCEPTIBILITY, FLAMMABILITY AND FIRE INTENSITY IN ALPINE PEATLANDS

The factors that influenced the percentage of *Sphagnum* burnt in Alpine Peatlands in the 2003 and 2006/07 alpine fires have been studied (UTAS 2015). The results are presented in a report “Prioritising Alpine Peatlands for Fire Mitigation Planning in Victoria” (UTAS 2015).

In summary, the key variables that have been found to have most influence on the percentage of *Sphagnum* burnt are (in order of importance),

1. climate variables (temperature, precipitation),
2. shrubiness,
3. topographic ruggedness,
4. woodland nearby,
5. size of catchment,
6. common vegetation,
7. topographic position,
8. topographic wetness and
9. shape.

The extent of fire incursion into peatlands is therefore dependent on these factors and observation of these characteristics in the field can assist fire-ground decisions around suppression. These factors have been used to predict the likely percentage of S*phagnum* burnt from a bushfire in each Alpine Peatland cluster (see below) and this used as an indicator of their future vulnerability to fire (UTAS 2015).

It is expected that the severity of burning across a Peatland system will also be influenced by the local fire direction and intensity and observations indicate the presence of shrubby flammable species in and around Alpine Peatlands is likely to carry the fire into the peatlands and fire impacts have been observed as greater in the shrub-dominated wet heath communities.

PRIORITISING ALPINE PEATLANDS.

Alpine Peatlands in Victoria are based and described collectively through 7 Ecological Vegetation Classes (EVC):

- EVC 171 Alpine Fen*
- EVC 210 Sub-alpine Wet Heathland *
- EVC 221 Sub-alpine Wet Heathland/Alpine Fen Mosaic #
- EVC 288-61 Alpine Valley Peatland (Raised Bog) *
- EVC 288-62 Alpine Valley Peatland (Valley Bog) #
- EVC 917 Sub-alpine Wet Sedgeland #
- EVC 1011 Alpine Peaty Heathland*

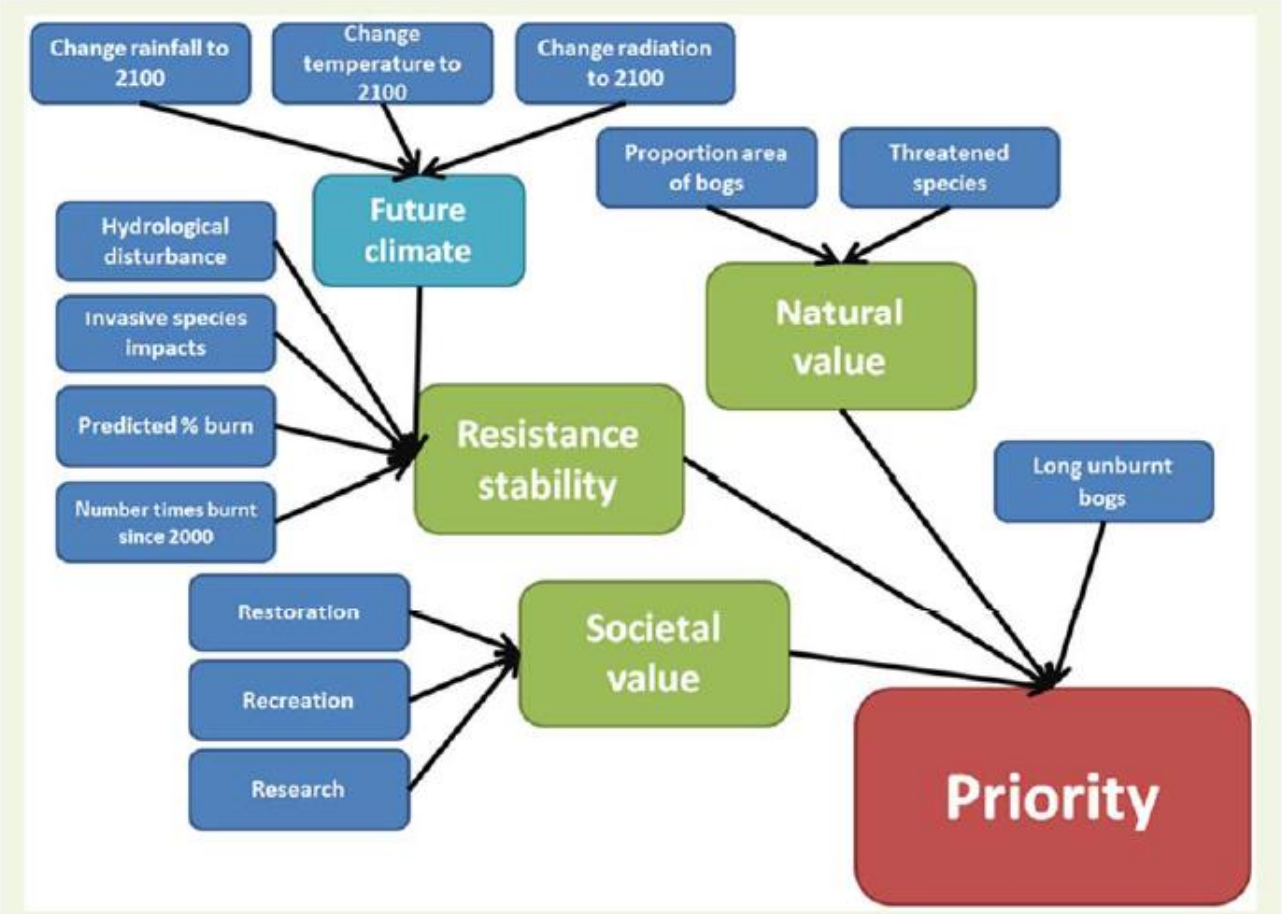
* these EVC's from the Alpine Peatland mapping layer.
# these EVC's are described but not mapped.

They have been mapped and updated as information is improved and maintained as a single digital layer which is maintained currently through the Arthur Rylah Institute (Tolsma 2015). The Alpine Peatlands are grouped into 100 VAPSAP sub-clusters (McMahon, et al; 2012).

A map and report prioritising peatland sub-clusters across alpine Victoria for their protection from fire has been produced (UTAS 2015) (refer Appendix 9), using the MCAS-S decision support tool (ABARES 2014). Priority is based on vulnerability (see above), along with ecological resistance stability, societal value, natural

values, future climate and the presence of long unburnt peatlands, see figure 1 below. MCAS-S provides the tool for applying different weightings to integration data to align with changing circumstances.

Figure 1 Means to ends diagram used by MCAS-S to prioritise Alpine Peatlands. The dark blue boxes indicate primary input data layers and all other boxes represent different levels of spatial data integration. The red box represents the final integrated product which is the basis for the map of each sub-cluster priority.



While the intention is to protect all peatlands from fire, the landscape scale principle is to give the highest priority for protection from fire to those peatlands that provide the best chance of maintaining landscape scale function and resistance stability (ability to resist fire) and protecting high natural and societal values.

Alpine peatland clusters are listed in order of priority importance into 10 classes then grouped into 4 key categories. They are;

Critical (classes 9-10)

These peatlands are critical to protect from fire and impact of fire operations due to their natural integrity and function being of the highest order due to one or a combination of the following factors: their long un-burnt status, incorporating most of the few clusters of peatland refugia in the alps landscape that have not been burnt in since 1939, low to moderate levels of disturbance, a high incidence of known threatened species, occupy much of the catchment and have high societal values for research and recreation. Collectively, these peatlands provide the best opportunity to maintain examples of peatlands in a functional to relatively undisturbed state.

High (classes 5-8)

These peatlands are a high priority to protect from fire and impacts of fire control operations. The state of these peatlands is suboptimal due to past disturbance from fire and most show moderate impacts from other factors. However, these peatlands show moderate degrees of resilience from these impacts and opportunity for their recovery and emergence to more-highly functioning peatlands should disturbances such as fire be removed or minimised.

Moderate (classes 3-4)

These peatlands are of moderate priority to protect from fire and impact of fire control operations. These peatlands have some degree of degradation due to past disturbances of fire and other factors. Many have a relatively small size and they are more vulnerable to further fire. These peatlands also tend to occupy the lower altitude areas and only represent a tiny proportional area of the cluster area and are often within a matrix of highly flammable forest types. While it is highly preferable to protect these peatlands from further fire, their medium term recovery to fully functioning peatland systems and long-term persistence is less certain.

Lowest (classes 1-2)

These peatlands are generally in a degraded state and severely disturbed by one or a combination of multiple fires, invasive species and other disturbance factors. They are small in overall catchment contribution, have lower societal values and are highly vulnerable to changes in state after further fires. While it is highly preferable to protect these peatlands from further fire, their recovery to fully functional peatlands is very uncertain and a change in state is possible for many.

The Alpine Peatland digital layer with the 10 classes and 4 Priority categories identified is accessible in Fireweb through EMap. **See Appendix 9.**

PART 2: MANAGING AND MITIGATING THE IMPACT OF BUSHFIRE AND FIRE SUPPRESSION ON ALPINE PEATLANDS.

BUSHFIRE MANAGEMENT FRAMEWORK

Bushfire management in Victoria is managed in accordance with the Code of Practice for Bushfire Management on Public Land 2012 (DSE 2012). The purpose of this Code is to provide a strong foundation and risk based framework under which bushfire is managed. This provides an appropriate methodology and process to develop actions for the mitigation of the impacts of bushfire on alpine peatlands.

The primary objectives in the Code for Bushfire Management on Public Land in Victoria are:

- To minimise the impact of major bushfires on human life, communities, essential and community infrastructure, industries, the economy and the environment. Human life will be afforded priority over all other considerations.
- To maintain or improve the resilience of natural ecosystems and their ability to deliver services such as biodiversity, water, carbon storage and forest products.

The Code addresses the approach to management of bushfires through 7 key functions; 1/ Risk-based Bushfire Management and Planning,2/ Prevention, 3/ Preparedness, 4/ Fuel Management, 5/ Response, 9/ Recovery and 7/ Monitoring, Evaluation and Reporting.

The 7 step framework of the Code for Bushfire Management on Public Land in Victoria (DSE 2012) is a useful methodology to consider plans, actions, strategies and tactics that may be employed to mitigate the impact of bushfire on Alpine Peatlands across the suite of bushfire management functions. All the results, outputs and recommendations of the project have been integrated into the 7 functions.

1 RISK-BASED BUSHFIRE MANAGEMENT AND PLANNING

The key outcome of this stage is the development of the Strategic Bushfire Management Plans (SBMP) for each Risk Landscape across Victoria. The SBMP identifies, evaluates and selects strategies that are most likely to achieve the primary objectives for bushfire management. This is applied at the operational level through a program of works and the annual implementation of actions. Tactical planning outlines specific actions including planned burns.

STRATEGIC BUSHFIRE MANAGEMENT PLAN (SBMP)

A study of the effect of fuel modification strategies on the risk to and likely impact of bushfire on alpine peatlands has been carried out to inform the development and review of Strategic Bushfire Management Plans (NSA 2015) (Refer Appendix 6). To inform this, each of 100 peatland clusters has been prioritized into one of 4 categories in order of importance for protection from fire (see above).

Bushfire spread prediction software (Phoenix) was used to model the likely spread of 1210 individual fire ignitions under 12 different weather scenarios. The modelling outputs predict the relative likely impact of each ignition source on alpine and sub alpine peatland clusters. This information was then been used to assess the effectiveness of 9 potential fuel treatment strategies, including the current Strategic Bushfire Management Plan (SBMP), (DELWP 2015), by estimating residual risk to each of the 100 peatland sub-clusters as a result of each treatment.

In general, it has found that while planned burn strategies, such as in the SBMP, can reduce residual risk to some degree, at a landscape scale planned burning will have limited effect on mitigating the impact of fire on peatlands largely because large areas of vegetation in the fire path and immediately surrounding peatlands are considered 'untreatable' due to ecological risks and therefore, are unsuitable for planned burning.

Nevertheless, recommendations to review SBMP burning strategies for 20 specific areas have been made, where they may reduce the residual risk to critical and high priority peatlands. These are reviewed in a report (Parks Victoria 2016) and summarised in Appendix 8. The Bushfire Risk landscape teams are now considering those recommendations.

Recommendation: The Alpine & North East, Alpine & Greater Gippsland and East Central Bushfire Risk Landscape Teams consider the observations and recommendations of the report "Analysis of Fire Behaviour and Scenario Modelling of Planned Burning Regimes to Mitigate Impacts on Alpine Peatlands" in the review of Strategic Bushfire Management Plans and Fire Operations Plans.

MULTI-CRITERIA ANALYSIS SHELL (MCAS-S)

The MCAS-S decision support tool (ABARES 2014) was used to present and weight a range of data that was collected for the purpose of prioritising alpine peatland importance to inform the SBMP (Refer Figure 1). The *Peatfire dataset* (UTAS 2015a) and the MCAS-S decision support tool (ABARES) have been provided to DELWP and Parks Victoria along with a working manual.

MCAS-S and the Peatfire datasets provide the data and tools for prioritising values and would be valuable to further analyse Alpine Peatland priorities as new or updated data becomes available, decisions on weighting certain values are changed or applying the package to other values at risk from fire.

MCAS-S should continue to be used by Bushfire Risk landscape teams and others as a decision support tool to consider risks to alpine peatlands and other assets as appropriate, from fire. Consideration may also be given to re-modelling priorities at the regional scale to inform decision making at a finer scale.

<u>Recommendation:</u> The Alpine & North East, Alpine & Greater Gippsland and East Central Bushfire Risk Landscape Teams consider the further application of MCAS-S to assist decision making around the threat of bushfire to natural values.

SPECIFIC TACTICAL PLANNING FOR PEATLAND AREAS

The characteristics of areas of Alpine Peatlands throughout the alps vary considerably in regard to priority of importance for protection, their vulnerability and localized specific values such as research and rehabilitation

areas. They also vary in regard to response aspects such as vehicle access and water availability. While they have been assessed across the landscape for relative vulnerability, importance and potential for reducing risk though planned burning, fire response options will vary considerably. It would be prudent for the land managers of areas with clusters of critical and high priority Alpine Peatlands to develop pre-determined local tactical plans to implement should fire become a threat.

These plans should consider, among other things;

- Any localized and more specific critical priorities for Alpine Peatlands.
- The long-term commitment of resources and methods that may be needed to round up fire and extinguish long-term smoldering of peat and organic soils post fire front.
- Potential tactical retardant line locations.
- Vehicle access.
- Potential edges that may be suitable for low impact line building or using vegetation changes, topography or moisture differentials.
- Water availability and access points for aircraft and ground vehicles.
- Access to and suitable location for pumps and long hose lines.
- Any specialist equipment that may be useful.

Priority areas for these plans are:

- Baw Baw Plateau.
- Bogong High Plains.
- Nunniong Plateau.

Others include

- Snowy/Wellington Plains.
- Mount Buffalo Plateau.
- Cobberas/Davies Plain.
- Lake Mountain.

- **Recommendation:** ***Parks Victoria and DELWP prepare pre-determined local tactical plans for bushfire response for areas with clusters of critical and high priority Alpine Peatlands to implement should bushfire become a threat. Priority should be on Baw Baw Plateau, Bogong High Plains and Nunniong Plateau.***

MAINTAINING MOISTURE OR WETTING PEATLANDS

Strategies to maintain as much moisture in peatlands or to wet peatlands at times of increased fire risk should also be considered. Such activities will include continuing current restoration programs that spread and hold water follow past fire or other disturbances. Given the predicted increases in severity and duration of drying for the alps, more active 'interventions' such as measures to deliver water to wet/moisten peatlands at risk may also be considered in the future and the issue actively discussed amongst stakeholders.

***<u>Recommendation:</u> Alpine Peatland restoration and rehabilitation works should focus on maintaining high levels of moisture to reduce the impact of fire*. See also "Further Investigation & Research" below.**

2 PREVENTION

Prevention is a general approach to reduce the incidence of fires caused by human ignition The key to prevention is the implementation of regulatory, enforcement and awareness strategies to reduce the incidence of bushfires caused by human ignition. There are no specific prevention strategies for Alpine Peatlands as they are part of the wider education and enforcement campaign for bushfire, however the impacts and risk of campfire escapes and other human activities on peatlands should be monitored and response put in place as appropriate.

3 PREPAREDNESS

Preparedness actions are undertaken in anticipation of bushfires to improve bushfire response performance.

This includes the development and maintenance of capabilities and resources. Readiness and response planning defines the readiness and initial attack procedures to be adopted to align with existing and forecast bushfire risk. Bushfire danger, behaviour and bushfire damage potential is monitored, along with a detection system for bushfire starts.

CAPABILITIES

A range of key staff including IMT, duty officers, air observers, air attack supervisors and others in relevant positions should have awareness about the identification, values, presence and vulnerability of Alpine Peatlands to fire and suitable methods and tactics for responding to fire, particularly in work centres with first attack responsibilities in areas with Alpine Peatlands. This should be incorporated into IMT training, regional workshops or specific training. Staff will be identified that can provide specialist advice on alpine peatlands to IMTs.

***Recommendation:* Develop and implement an Alpine Peatlands training program to be designed and delivered to a wide range of Fire Personnel, targeted to their specific roles.**

DETECTION

The existing detection network provides sufficient coverage for rapid response to fire starts near or threatening Alpine Peatlands.

READINESS AND RESPONSE PLANNING

Readiness and response planning defines the readiness and initial attack procedures to be adopted at a regional level. Guidelines for preparing for fires that may impact on Alpine Peatlands should be included in Hume and Gippsland Region Readiness and Response Plans.

A section in the R&R Plan on Alpine Peatlands should include :

- Appropriate suppression methods to minimize environmental impact on Alpine Peatlands.
- Resource and values information and tools available such as Alpine Peatlands mapping on eMap.
- Contact details for Alpine Peatland specialists in the regions that may be called on for advice.

- Advice regarding the differing scenarios where it is appropriate to use retardants, foams and water in and around alpine peatlands.
- Consideration of predetermined aircraft and rappel crew dispatches and hazardous tree mapping for responding to peatland fires.
- Link to Guideline "Response to Bushfire in Alpine Peatlands; a Guideline for Incident Management Teams" and a Work Instruction "Management of Alpine Peatlands Values during Fire Response".
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***Recommendation:** That the Hume, Gippsland and Port Philip DELWP Region Readiness and Response Plans are updated to include a section on responding to bushfire that threatens Alpine Peatlands with the information listed above.*

WORK INSTRUCTION

A draft Work Instruction (as part of the Fire Suppression SOP) "Management of Alpine Peatlands Values during Fire Response" has been produced and is being institutionalised within the Office of the DELWP Chief Fire Officer. On approval, it will be available through Fireweb and if appropriate, the EMV Portal. This includes an advice page that can be inserted in IAPs for fire-ground personnel. (Refer Appendix 4 for Work Instruction Decision Tree).

***Recommendation:** The Work Instruction "Management of Alpine Peatlands Values during Fire Response" is approved by DELWP Chief Fire Officer and incorporated into the Fire Suppression Manual and SOP Work Instructions on Fireweb and if appropriate, the EMV Portal.*

EMAP & CONSEQUENCE REPORTS

The Alpine Peatlands layer with priority sub cluster categories is now available on eMap for easy and quick access for IMT to key spatial information and to run consequence reports (refer Figure 2). A further improvement would be providing links on consequence reports to key documents such as the Alpine Peatlands Work Instruction and Guideline. The development of a warning system where the predicted impact of a fire on high values such as Alpine Peatlands generates a warning has also been suggested by fire managers.

Recommendation: The eMap Alpine Peatlands layer is utilised by IMT's to determine threats to Alpine Peatlands from a bushfire incident and the layer is built into the consequence reporting process with links to key documents for procedures and advice.

SPECIALIST EQUIPMENT

Responding to fire in alpine peatlands requires care and caution to minimise long term impacts of the bushfire and the fire suppression activity. Fire can enter peatlands from adjoining heathland and grasslands after the main fire activity has passed and peatlands fires can burn and smoulder for long periods. Alpine Peatlands are usually difficult to access to extinguish by ground based vehicles and aerial bombing can be expensive and still needs ground crew follow up. It is worthy of exploring other options of getting water to Alpine Peatlands and surrounds with minimal impact. This could include setting up kits of hose lines, collar

tanks, large tanks, and pumps to fly in or small quick spray type units for ease of movement in difficult terrain. The use of small 'soft tracked' and potentially air lift-able machinery may be feasible. The use of needle stick injection of water directly into peat and organic soils (such as done in Indonesian peat fires (Wetlands International 2005) to reduce post-fire front smouldering should also be investigated.

***Recommendation:* Investigate suitable specialist equipment that can be located in strategic areas to respond to Alpine Peatland fires.**

4 FUEL MANAGEMENT (INCLUDING PLANNED BURNING)

A key tool used to reduce the impact of major bushfires is planned burning, which seeks to reduce the overall fuel and bushfire hazard in the landscape and can assist bushfire suppression actions by reducing the intensity and severity of bushfires. Planned burning is undertaken for many purposes including to maintain or improve the resilience natural ecosystems, and their ability to deliver services such as biodiversity, water, carbon storage and forest products. Planned burning activities are undertaken in a way that protects soils and water quantity and quality by measures that minimize the impact of bushfire management activities on the physical, chemical and biological qualities of streams and wetlands and soils. Fuel breaks may also be utilised.
Strategic bushfire management plans (see above; Risk-based bushfire management and planning) use Fire Management Zones as a tool to implement local bushfire management objectives. The four Fire Management Zones are Asset Protection Zone, Bushfire Moderation Zone, Landscape Management Zone and Planned Burning Exclusion Zone.

The report *Analysis of Fire Behaviour and Scenario Modelling of Planned Burning Regimes to Mitigate Impacts on Alpine Peatlands* found that planned burning is limited in its ability to reduce residual risk to Alpine Peatlands from bushfires (NSA 2015). Peatlands are surrounded by vegetation types not generally considered appropriate or suitable for planned burning. This includes adjoining treeless alpine and sub-alpine areas, Snow Gum woodland and forest, montane forests and Wet Sclerophyll Forests (Cheal 2010).

The continued development of the Strategic Bushfire Management Plans will consider the likely impact of planned burning on mitigating risk to Alpine Peatlands and will also consider a number of recommendations (see 1 above).

The application of planned burning in accordance with SBMPs will continue to provide some level of risk reduction for Alpine Peatlands. Consideration may be given to reduce shrubbiness by light slashing or localized burning around critical or high priority peatlands however; a full evaluation of the impact on other high values must be carried out.

***Recommendation:* Fire Operations Plans reflect the observations and recommendations of the report "Analysis of Fire Behaviour and Scenario Modelling of Planned Burning Regimes to Mitigate Impacts on Alpine Peatlands" (Refer Appendix 8) and (NSA 2015). See also "Further Investigation & Research" below.**

5 RESPONSE

Bushfires are suppressed and managed to reduce the risk to human life (the highest priority), communities, essential and community infrastructure, industries, the economy and the environment. The key activities in the response phase are to develop and implement tactics and allocate resources commensurate with bushfire risk to bring the bushfire under control in accordance with an Incident Action Plan. The aim is to manage the response efficiently and effectively, identify and mitigate risks and seek to minimise environmental damage.

It is important to understand the context of the bushfire and it likely impact on Alpine Peatlands. This will be influenced by a number of factors including where the bushfire starts, its likely path relative to the environmental conditions and the moisture levels of alpine wetlands will determine the likely fire severity and impact. These factors are presented in more detail in Part 1; Impact of Fire on Alpine Peatlands; The factors that influence susceptibility, flammability and fire intensity in Alpine Peatlands.

Emergency stabilisation and initial recovery is part of the response phase. This includes identifying, assessing and treating emerging risks to human life, property, natural, cultural and social values and rehabilitating damage caused by suppression works.

A range of potential strategies and tactics have been developed to guide IMT's during response to a bushfire threatening Alpine Peatlands.

Strategies and tactics for response to bushfires threatening Alpine Peatlands were developed through the participation of about 40 DELWP, Parks Victoria and Alpine Resort staff in four workshops. Three Phoenix generated scenarios (FFDI 60) likely to impact at different stages on Critical category Alpine Peatlands on the Bogong High Plains and Baw Baw and Nunniong Plateaus were presented and response options discussed. The outcomes are summarised below and outlined in more detail in Appendix 1.

These strategies and tactics have been incorporated into a Guideline "Response to Bushfire in Alpine Peatlands; a Guideline for Incident Management Teams" that is to be available through Fireweb. Strategies and tactics have been designed to explore options using scenarios of bushfires in three stages of impact on Alpine Peatlands.

In any fire there are many considerations that need to be taken into account and balanced, with life and property being the highest priorities. In responding to a bushfire threatening Alpine Peatlands, the IMT will evaluate these suggested strategies and tactics for response against competing priorities.

<u>Recommendation:</u> The Guide "Response to Bushfire in Alpine Peatlands; a Guideline for Incident Management Teams" is approved by DELWP Chief Fire Officer and located with similar guidelines on Fireweb and if appropriate, the EMV Portal.

SUMMARY: FIREGROUND TACTICAL CONSIDERATIONS AND OPTIONS

The following is **a summary** of strategies and tactics detailed further in Appendix 1 "Strategic and Tactical Guidelines for Responding to Bushfire Threatening Alpine Peatlands".

OVERALL

- IMT must maintain awareness, information and intelligence on the presence, location and importance status of Alpine Peatlands and the level of threat from bushfire throughout the fire incident.
- IMT must consider appropriate minimal impact methods to mitigate the impact of the bushfire and suppression operations on alpine peatlands.

STAGE 1 BUSHFIRE START WITH POTENTIAL TO IMPACT ON ALPINE PEATLANDS

At the start of a bushfire, should FBAN predictions, consequence reports, judgment or local knowledge highlight a potential threat to Alpine Peatlands, awareness of the risk and some pre-planning for that occurrence starts now including identifying from eMap the priority category of Alpine Peatlands threatened.

- Natural Values Officers and/or peatland specialists should be brought in early for advice.
- Strategies and tactics should be developed to:
  1. Steer and flank the fire away from the projected fire path into Alpine Peatlands should first attack fail and the likelihood of fire impacting on Alpine Peatlands builds.
  2. Prioritise protection of Alpine Peatlands in accordance with its category of importance of protecting from fire.
  3. Prepare for response to fire impacting on alpine peatlands with minimal impact suppression techniques such as use of retardant lines or water bombing. Plan for safe ground access if possible for crews and equipment likely to be needed.

STAGE 2 BUSHFIRE STARTING TO IMPACT ON ALPINE PEATLANDS

As the bushfire approaches Alpine Peatlands take the opportunity to slow and halt the fire before it impacts, and extinguish fire as it enters, utilising minimal impact techniques. Aerial bombing may be the only feasible option while ground access is being evaluated. Aim to steer the fire away from unburnt peatlands in the fire path and prioritise mitigating impact on Critical and High priority category Alpine Peatlands.

Distribute through the ISP the one *page Alpine Peatland Fireground Protocol* (accessible through the Work Instruction 5.5.1.X "Management of Alpine Peatlands Values during Fire Response") for crews working on fireground in and around Alpine Peatlands.

Tactics to consider include:

- Air attack on the fire edges approaching peatlands through retardant lines being laid between the fire and peatlands making tactical use of treeless areas to get retardant directly onto the ground.
- Air attack on fire in peatlands through dropping water directly into or adjacent to burning peatlands.
- Halt other unbound fire edges behind the main front that have potential to impact on alpine peatlands.
- Identify more highly critical peatlands from local knowledge and tactics to protect.
- Consider fall-back positions using existing tracks and where suitable onground resources may be utilised to support air attack, such as ground crews, long hose lines, hand trails, etc.
- No off track machinery use in treeless areas.

STAGE 3 FIRE PASSED THOUGH ALPINE PEATLANDS AND ACTIVELY BURNING WITHIN

As the fire activity moderates in treeless areas behind the front, take the opportunity to prevent further burning out of Alpine Peatlands from flank expansion and burning out within the fire effected area prioritising mitigating the impact on Critical and High priority category Alpine Peatlands. There will be opportunity with moderation to start to get crews on ground to consolidate air attack. This stage may occur over a long period until Alpine Peatlands are extinguished by intense ground work or sustained rain.

Distribute through the ISP the one page *Alpine Peatland Fireground Protocol* (accessible through the Work Instruction 5.5.1.X "Management of Alpine Peatlands Values during Fire Response") for crews working on fireground in and around Alpine Peatlands.

Tactics to consider include:

- Air attack on the fire flanks and front where possible laying retardant lines to dead edge or slow fire making tactical use of open treeless areas to get retardant directly onto the ground.
- Halt other unbound fire edges in the fire affected area that may continue to burn into alpine peatlands.
- Air attack on running edges in grasslands with water or foam to dead edge.
- Air attack on fire in peatlands burning in fire affected area through dropping water directly into or adjacent to burning peatlands.
- Where road or track access permits for tankers, run out hose lines to dead edge in grasslands and extinguish fire in peatlands.
- Air lift in collar and/or large tanks, hose lines pumps and crew to remote areas to dead edge and extinguish fire in alpine peatlands.
- Prepare fall back lines on existing road network or minimum impact containment line building in robust areas such as wooded ridges where it protects critical peatlands.

TAKE CARE

- Avoid "burning out" peatlands to containment lines. Dead edge or bring fire to robust wooded areas on ridge lines so crews can deal with fire with hand trails or light touch machinery.
- No off track machinery use in treeless areas. (although careful use of soft impact slashing/mulching machinery may be suitable and useful, but not in Alpine Peatlands)
- Avoid digging within peatlands to extinguish substrate/peat fires.
- As onground work proceeds, consider potential of significant weeds and/or pathogens to enter alpine peatlands from fireground activity and take necessary actions to prevent.

6 RECOVERY

The recovery phase is a transition from Incident Control (once the Incident Management Team (IMT) has been disbanded) to business-as-usual as the public land management entity resumes responsibility for land impacted by bushfire for day to day management responsibilities and longer term recovery. Recovery Plans outline the process and actions to protect human life, property, and natural and cultural values by stabilising public land, repairing damage and treating impacts that have resulted from bushfire. There are two phases:

EMERGENCY STABILISATION

The IMT will manage emergency stabilisation work which is often where soils are unstable due to machinery disturbances or intense fire. This may affect water quality. The application of minimal impact suppression techniques in and around alpine peatlands should avoid any need for emergency stabilisation, however, should machinery impacts occur, these should be immediately stabilised. The Bushfire Rapid Risk Assessment Team (RRAT) will be brought in to assess risks and any initial Alpine Peatland rehabilitation work that is required to be done by the IMT and will inform the preparation of a recovery plan.

RECOVERY

A Recovery Plan should be produced in the event of fire impacting on Alpine Peatlands and will be the responsibility of the land manager. Recovery Plans outline the process for repairing damage and treating impacts that have resulted from bushfire, beyond emergency stabilisation. Much has been learnt about both natural and interventionist recovery of Alpine Peatlands across the Australian Alps, following in particular the 2003 and 2006/07 fires. This is well documented, including in the Australian Alps Green Book Rehabilitation Field Guide. https://theaustralianalps.wordpress.com/the-alps-partnership/publications-and-research/green-books-rehabilitation-guides/.

RECOVERY AND RESTORATION PRINCIPLES

Approaches to recovery restoration broadly fall within two categories:

1. Assisted natural recovery or the 'ecological approach': Those that ameliorate extreme conditions to make areas more favourable for natural colonisation of vegetation
2. Artificially induced recovery: More intensive treatments that include the addition of external materials such as soils and propagules.

The assisted natural recovery approach would generally be appropriate for an ecosystem assessed as having high or moderate resilience. The aim of this approach would be to include treatments that focus on restoring hydrological functionality to increase residence time and infiltration of water, and also address factors limiting the resilience of the peatland; such as, invasive species, unstable substrates and exposure to environmental extremes. This approach may include some moisture holding assistance and also include seeding or seedlings of local provenance species if the local sources of diaspores are limited or there is an inadequate seed bank for natural recruitment.

Artificially induced recovery and does not generally focus as heavily on the restoration of natural ecosystem functioning and may only be considered in extreme cases where a change of ecological State is likely. It often aims to directly replace biotic components of the ecosystem. Artificially induced recovery treatments may also include interventions such as sowing areas with native and exotic species seedling transplants addition of organic matter and compost and addition of nutrients, fertilizer and the importation of mulch materials such as straw and jute or geo-textile matting.

Recommendation: Rehabilitation and Recovery of Alpine Peatlands following bushfire is undertaken and guided by the Australian Alps Green Book Rehabilitation Field Guide and previous learnings.

7 MONITORING, EVALUATION AND REPORTING (MER)

Monitoring, evaluation and reporting assesses the performance of bushfire management strategies and actions in achieving the two primary objectives for bushfire management on public land. The learnings from a science based approach are publically accessible and used to improve bushfire management and decision making.

Monitoring programs focus on (*among other things),* fire ecology and ecosystem resilience and on areas where the results are likely to have the biggest impact on decision making, including ecosystems that are most valuable and vulnerable to the impact of major bushfires and inappropriate fire regimes. Monitoring, evaluation and reporting will assess the performance of bushfire management strategies and actions and identify knowledge gaps and further research needed. While protecting life and property is the foremost priority for MER, strategies aimed at ecosystem resilience, including ecosystems such as Alpine Peatlands that are most valuable and vulnerable to the impact of major bushfires and inappropriate fire regimes, can also be measured for effectiveness.

The MER process should assess the effectiveness of:

- Planned burning regimes that contribute to mitigating the impact of fire on Alpine Peatlands.
- Readiness and Response Plans and Work Instructions aimed at mitigating the impact of fire on alpine peatlands, in the course of fire incidents.
- Mitigation of the impact of fire on Alpine Peatlands in the course of fire incidents.
- Interventionist and natural recovery of alpine peatlands following fire incidents.

The Planning/Intelligence Unit should assess the effectiveness of this Alpine Peatland Guideline and strategies and tactics used to mitigate the impact of bushfire fire on Alpine Peatlands during the course of an incident and report to the appropriate DELWP Regional Bushfire Risk Landscape Team for inclusion into the MER process. The Land Manager should also report on interventionist and natural recovery of alpine peatlands following fire incidents. This reporting will improve response and recovery strategies and tactics through learning by “doing and evaluating”.

***Recommendation:* The effectiveness of planned burning, instructions and guidelines, response strategies and recovery, in relation to fire impacting Alpine Peatlands, is to be included in the Regional MER program to inform reviews and continuous improvement.**

TOOLS AND GUIDELINES

There is strong support within fire managers and operatives for instructions and guidelines for Alpine Peatland fires that easily accessible, concise yet informative and institutionalised into existing procedures and training programs. Key tools supported include:

- The Work Instruction "Management of Alpine Peatlands Values during Fire Response" including one page advice for fireground crews and advice on the use of retardants and/or foams,
- The Guide "Response to Bushfire in Alpine Peatlands; a Guideline for Incident Management Teams"
- Regional Readiness and Response Plan: peatland procedures addressed,
- eMap peatland layer with importance category and drill down data if possible, and
- FBAN predictive work and consequence reports.

FURTHER INVESTIGATION AND RESEARCH

Fire practitioners and technical experts have suggested the following as topics that should be the subject of further investigation and research to improve response:

(1) Specialist equipment and lift in kits that could safely assist ground crews dead edge and extinguish fire in and around alpine peatlands (see Specialist equipment in 3 above).
(2) Off track minimal impact ground transport that may be suitable to transport water to alpine peatland fires.
(3) The impacts and appropriate use of, retardants and chemical foams on alpine peatlands.
(4) Development of pre-planned local tactical plans for specific areas.
(5) Ability to drill down into the peatland layer on eMap for detailed values information on each peatland sub cluster.
(6) Warning on eMap to highlight the interaction of bushfire predictions with alpine peatlands.
(7) Better understanding and calibration of peatland moisture status and organic soil moisture indices with available Bureau of Meteorology measures.
(8) Water diversion tools, structures and licence agreements (if required) to wet critical peatlands and stakeholder values discussion about considering such interventionist techniques.
(9) Localised removal of flammable vegetation adjacent to alpine peatlands to create fuel breaks during response and fuel management through:
    - slashing by hand;
    - off track minimal impact mulcher/slashers; and
    - targeted burning.

Recommendation: Further investigation and research is prioritised and undertaken to explore a range of suggested actions that may improve the preparedness and response to bushfire impacting Alpine Peatlands.

IMPLEMENTATION PLAN

Function in Bushfire Code	Action	Implementation
Risk-based Bushfire Management and Planning	The Alpine & North East, Alpine & Greater Gippsland and East Central Bushfire Risk Landscape Teams consider the observations and recommendations of the report "*Analysis of Fire Behaviour and Scenario Modelling of Planned Burning Regimes to Mitigate Impacts on Alpine Peatlands"* in the review of Strategic Bushfire Management Plans and Fire Operations Plans.	Bushfire Risk Landscape Teams
Risk-based Bushfire Management and Planning	That the Alpine & North East, Alpine & Greater Gippsland and East Central Bushfire Risk Landscape Teams consider the further application of MCAS-S to assist decision making around the threat of bushfire to natural values.	Bushfire Risk Landscape Teams
Risk-based Bushfire Management and Planning	That the Hume, Gippsland and Port Philip DELWP Region Readiness and Response Plans are updated to include a section on responding to bushfire that threatens Alpine Peatlands with the information listed above.	DELWP Regional Fire
Risk-based Bushfire Management and Planning	Parks Victoria and DELWP prepare pre-determined local tactical plans for bushfire response for areas with clusters of critical and high priority Alpine Peatlands to implement should bushfire become a threat. Priority should be on Baw Baw Plateau, Bogong High Plains and Nunniong Plateau.	Parks Victoria and DELWP District Managers
Risk-based Bushfire Management and Planning	Alpine Peatland restoration and rehabilitation works should focus on maintaining high levels of moisture to reduce the impact of fire.	Parks Victoria and DELWP District Managers
Preparedness	Develop and implement an Alpine Peatlands training program to be designed and delivered to a wide range of Fire Personnel, targeted to their specific roles.	Project Director# with DELWP fire training unit.
Preparedness	The Work Instruction ***"Management of Alpine Peatlands Values during Fire Response"*** is approved by DELWP Chief Fire Officer and incorporated into the Fire Suppression Manual and SOP Work Instructions on Fireweb and if appropriate, the EMV Portal.	Project Director# with Office of Chief Fire Officer.
Preparedness	The eMap Alpine Peatlands layer is available for IMT's to determine threats to Alpine Peatlands from a bushfire incident and the layer is built into the consequence reporting process with links to key documents for procedures and advice.	Project Director# with Office of Chief Fire Officer
Preparedness	Investigate suitable specialist equipment that can be located in strategic areas to respond to Alpine Peatland fires.	Project Director# with Parks Victoria and DELWP District Managers
Fuel Management	Fire Operations Plans reflect the observations and recommendations of the report "Analysis of Fire Behaviour and Scenario Modelling of Planned Burning Regimes to Mitigate Impacts on Alpine Peatlands" (Refer Appendix 8) and (NSA 2015).	Bushfire Risk Landscape Teams with DELWP and Parks Victoria District Managers.

Response	The Guide ***"Response to Bushfire in Alpine Peatlands; a Guideline for Incident Management Teams"*** is approved by DELWP Chief Fire Officer and incorporated into similar guidelines on Fireweb and if appropriate, the EMV Portal.	Project Director# with Office of Chief Fire Officer.
Recovery	Rehabilitation and Recovery of Alpine Peatlands following bushfire is undertaken and guided by the Australian Alps Green Book Rehabilitation Field Guide and previous learnings.	IMT Planning Officer and Land Manager.
Monitoring, Evaluation and Reporting	The effectiveness of planned burning, instructions and guidelines, response strategies and recovery, in relation to fire impacting Alpine Peatlands, is to be included in the Regional MER program to inform reviews and continuous improvement.	Bushfire Risk Landscape Teams
General	The report: "*Mitigating the Impact of Fire on Alpine Peatlands*" is produced as a DELWP Technical Report.	Project Director# and DELWP Fire Planning Standards section.
General	Further investigation and research is prioritised and undertaken to explore a range of suggested actions that may improve the preparedness and response to bushfire impacting Alpine Peatlands.	Project Director# and Land Managers.

 # Project Director: Alpine Peatlands Fire Risk Mitigation Planning Project (Parks Victoria; Eastern Region). Action expected to be implemented within the project scope, by 2018.

ACKNOWLEDGEMENTS

The Project Director is Daniel Brown and the Project Manager, Dan Jamieson, both of Parks Victoria. The project has been co-ordinated by Peter Jacobs, consultant to People in Nature http://www.peopleinnature.net

The project has been developed through 5 stages;

The report for stages one and two; "*Prioritising Alpine Peatlands for Fire Mitigation Planning in Victoria*", including the development and mapping of priority categories was overseen by Regina Magierowski of the University of Tasmania with Anita Wild and a team of specialist staff from the University.

The report for stage three "Analysis of Fire Behaviour and Scenario Modelling of Planned Burning Regimes to Mitigate Impacts on Alpine Peatlands" was developed by Owen Salkin of Natural Systems Analysis (NSA).

The strategies and tactics for stage 4 were developed through the contribution of about 40 DELWP, Parks Victoria and Alpine Resort staff from a range of fire and land management roles to workshops run in Ovens, Traralgon, Bairnsdale and Orbost early in 2016. The Phoenix generated scenario (FFDI 60) for the Bogong High Plains used for the final report is one of three that were presented to workshops. Other scenarios included Baw Baw and Nunniong Plateaus, included in Appendix 3. This report combines and incorporates the comments and outcome of all 3 scenarios and 4 workshops.

In Stage 5, the draft Work Instruction "Management of Alpine Peatlands Values during Fire Response" and the draft guide: "Response to Bushfire in Alpine Peatlands; a Guideline for Incident Management Teams", along with this final report was prepared by Peter Jacobs.

The Project Working Group and Project Implementation Steering Committee have provided valuable guidance and comment, in particular the external technical specialists Arn Tolsma, Anita Wild and Dick Williams.

The Victorian Alpine Peatland Protection Program is an initiative jointly funded through Parks Victoria, the West Gippsland Catchment Authority and the Australian Government's National Landcare Programme (via North East, West Gippsland and East Gippsland Catchment Management Authorities).

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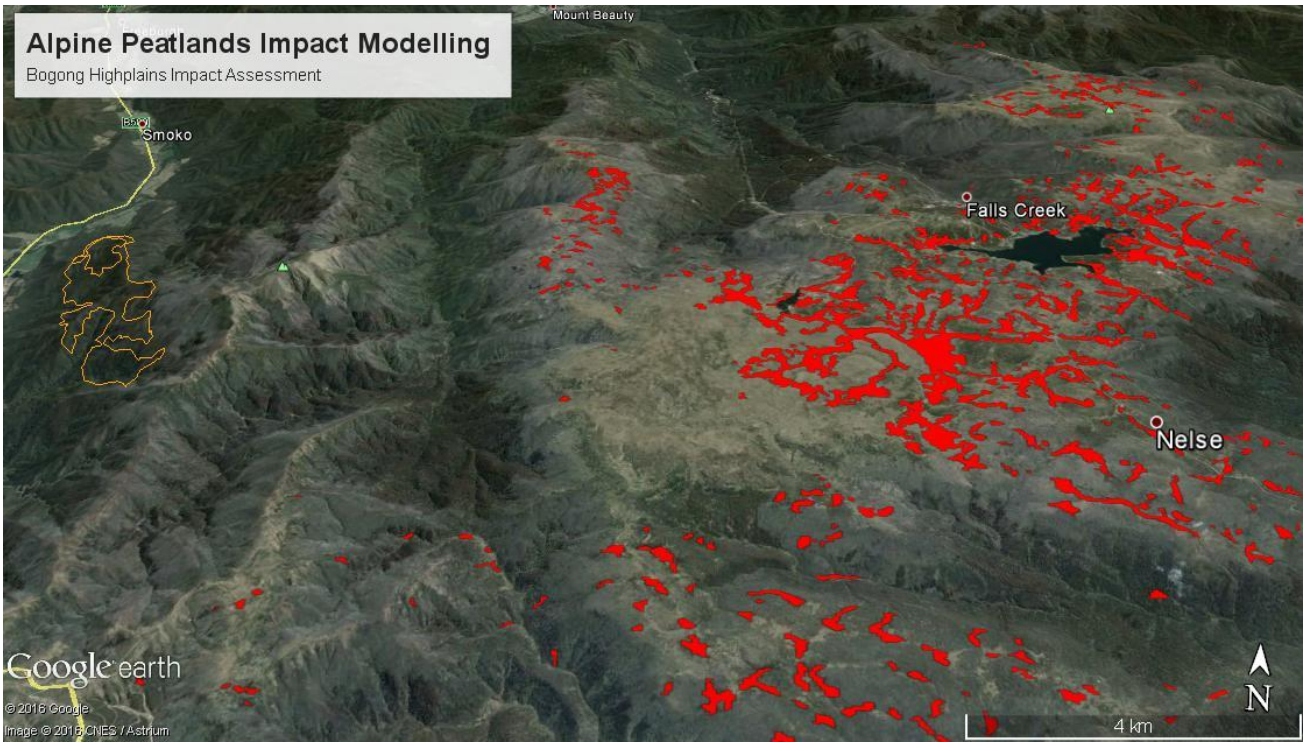
APPENDIX 1 STRATEGIC AND TACTICAL GUIDELINES FOR RESPONSE TO BUSHFIRE THREATENING ALPINE PEATLANDS

The following guidelines for strategies and tactics to mitigate the impact of fire on Alpine Peatlands uses an example of on a Phoenix generated fire scenario (FFDI 60) that impacts on clusters of Critical Alpine Peatlands on the Bogong High Plains. The response can guide other Alpine Peatland fire situations.

STAGE 1 BUSHFIRE START WITH POTENTIAL TO IMPACT ON ALPINE PEATLANDS

SITUATION

A fire has started and is out of control, with the potential fire path impacting on alpine peatlands. The focus will be on early containment of the fire (which is the best outcome for peatlands) and risk to life and property. It will be challenging to capture the attention of the IMT on this given other critical issues at hand. Awareness of the risk to Alpine Peatlands and some pre planning for that occurrence will be a secondary but important factor. This will be a focus of the planning and intelligence units and will need additional resources early. Conditions such as moisture levels and the fire trajectory should be assessed to determine the likely impact of fire should it reach Alpine Peatlands.



Bushfire start with potential to impact on critical alpine peatlands on Bogong High Plains (in red)

Considerations at this point in time in specific regard to alpine peatlands include:

AWARENESS

Fire behaviour analysis and prediction and consequence reports will trigger awareness that the fire has potential to impact Alpine Peatlands over the next 48 hours. The Planning/Intelligence Officer should start a constructive conversation with the Incident Controller about the potential risk to alpine peatlands, along with other values of state wide importance i.e. water & timber resources.

PLANNING AND INTELLIGENCE

- Planning/Intelligence unit should utilise Emap to access data on the location of alpine peatlands that are in the potential fire path and their category of importance .
- Fire behaviour specialists to determine more accurately, including consideration of peatland moisture levels (from BoM data) the likely impact and timing of impact on Alpine Peatlands and generate a consequence report.
- Natural Values Officers and peatland specialists should be brought in to advise on strategies that may be appropriate should the fire escalate to that point. This should include drilling down further into priority category data to determine more detail on locally critical factors for each peatland that may further prioritise response (eg rehabilitation areas, long unburnt and threatened species particularly susceptible to fire).
- Prepare plans for first fall-back position to steer and flank the fire away from the projected fire path into Alpine Peatlands to be implemented should current attack fail and likelihood of fire impacting on Alpine Peatlands builds. This should consider using the strategic road network to potentially avoid the fire impacting on alpine peatlands and other values such as wilderness and reference areas, cultural heritage and threatened species.
- Prioritise protection of Alpine Peatlands in accordance with protection category.
- Prepare detailed minimum impact suppression tactics for the event of fire impacting on alpine peatlands such as where retardant lines or water bombing may be most effective and appropriate (see Appendix 1), what safe ground access may exist and resources and equipment likely to be needed.
- Determine a trigger point for determining if and when to implement actions to respond to fire impacting on alpine peatlands.

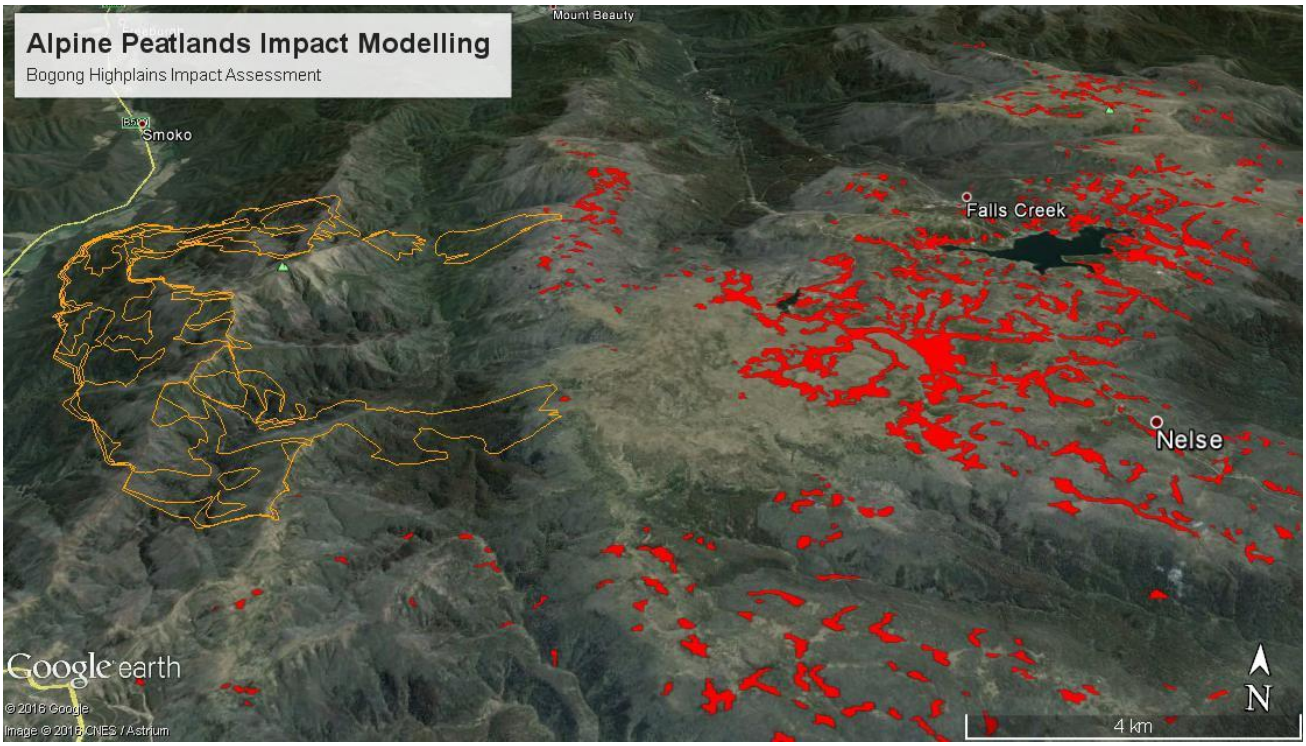
STRATEGIES

- Containing and controlling the fire early to reduce risk must be a priority.
- Start preparing lines for first fall-back position to steer and flank the fire away from the projected fire path into alpine peatlands.

STAGE 2 BUSHFIRE STARTING TO IMPACT ON CRITICAL ALPINE PEATLANDS

SITUATION

First attack and fall-back strategies to prevent the fire impacting on Alpine Peatlands have failed and the fire is just starting to impact on the alpine treeless area. Fire behaviour has slowed as the FFDI has decreased with altitude and the topography has flattened out somewhat. The main head of the fire has split into two narrow fingers. The focus is clearly now on the impact of the fire and fire suppression directly on alpine peatlands and the bushfire's potential to impact on extensive critical Alpine Peatlands to the east and south east. The use of ground crews in unlikely to be safe (although tree risk is low) so heavy reliance will be on aircraft until the fire risk has reduced. Smoke may make aircraft use difficult.



Bushfire starting to impact on critical alpine peatlands on Bogong High Plains (in red)

Considerations at this point in time in specific regard to alpine peatlands include:

AWARENESS

A high level of awareness in IMT that the fire is in a highly sensitive ecosystem and it is critical to mitigate the impacts of bushfire and fire suppression. IMT being informed of minimum impact suppression tactics and be clear about what tactics should and should not be employed.

PLANNING AND INTELLIGENCE

- Locate and implement Work Instruction Work Instruction 5.5.1.X "Management of Alpine Peatlands Values during Fire Response" on Fireweb .
- Prepare suitable minimum impact suppression tactics of fire suppression in response to bushfire in Alpine Peatlands for preparation of IAP.
- Distribute through the ISP the one page protocol (accessible through the Work Instruction 5.5.1.X "Management of Alpine Peatlands Values during Fire Response") for crews working on fireground in and around Alpine Peatlands.
- Develop minimum impact suppression tactics that will steer the fire way from large peatland clusters, some smaller, more isolated or difficult to access peatlands may be sacrificed unless there are very critical values at risk.
- Prepare fall-back plan with potential control lines, using existing tracks if possible should current direct attack fail.
- Consider fall-back positions where suitable resources may be available such as alpine resorts, crews, sprinklers, long hose lines, hand trails, existing track networks etc.
- Identify tactics to protect locally more highly critical peatlands (identified in Stage 1).

STRATEGIES

- Pre-emptive laying of retardant lines to slow or prevent fire entering alpine peatlands.
- Direct air attack on fire edges threatening alpine peatlands.
- Halt other unbound fire edges behind the main front that have yet to cross containment lines.
- Start preparing fall back control lines in suitable locations.
- No machinery use off existing tracks in treeless areas .

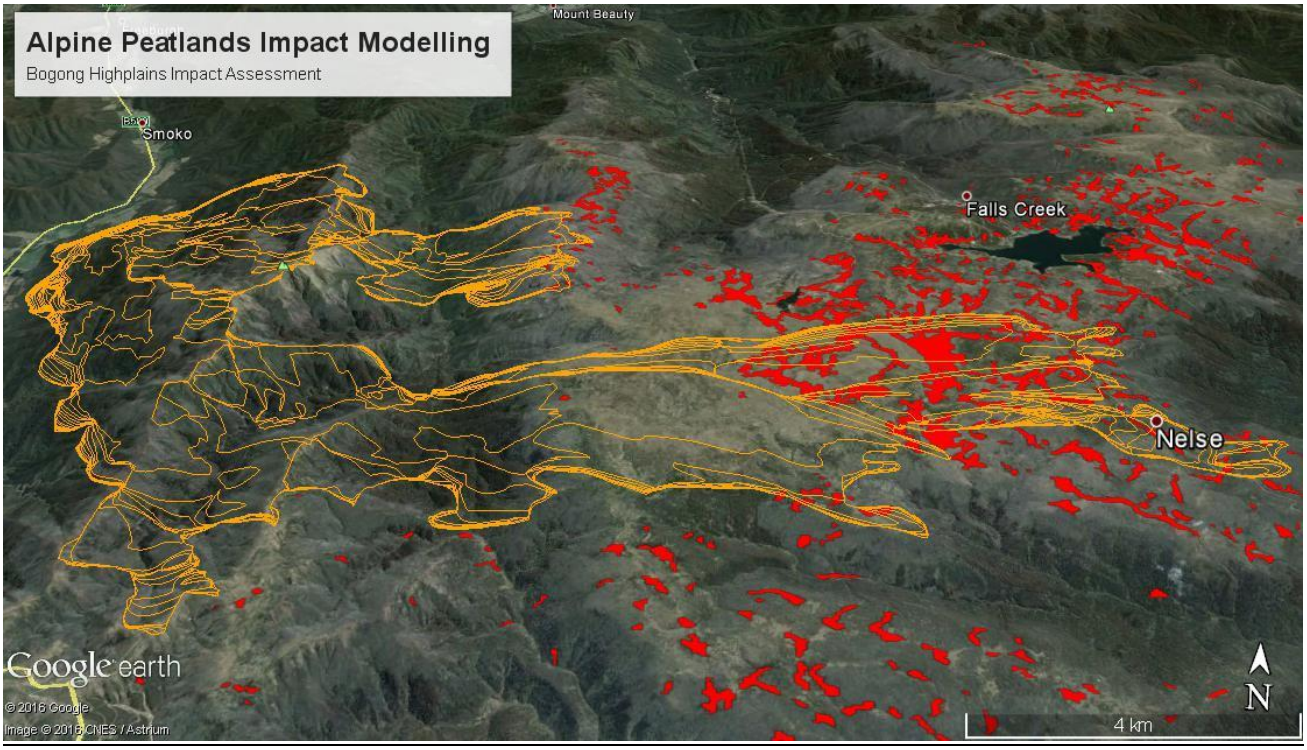
TACTICS

- Air attack on the fire edges approaching peatlands through retardant lines being laid between the fire and peatlands making tactical use of treeless areas to get retardant directly onto the ground.
- Air attack on fire in peatlands through dropping water directly into or adjacent to burning peatlands, taking advantage of quick turn-around to water source in nearby dams. (see Appendix 1).

STAGE 3 BUSHFIRE PASSING THROUGH CRITICAL ALPINE PEATLANDS

SITUATION

Direct attack failed as one of the fire fronts has moved slowly into alpine peatlands while the other has progressed rapidly and passed through a significant area of critical alpine peatland. The main fire front is moving out of the alpine peatland area, however, there is more slow movement of the fire flanks to the south and north/north east. Peatlands that have been burnt over will still be smouldering and some unburnt peatlands may still be ignited by fire moving around in grassland and heathland within the fire effected area.



Bushfire passing through critical alpine peatlands on Bogong High Plains (in red)

Considerations at this point in time in specific regard to alpine peatlands include:

AWARENESS

A high level of awareness in the IMT, that while the main fire front is passing though, critical peatlands are still being impacted by the slower moving flanks of the fire passing though treeless and woodland areas, (which could increase with wind changes) and the fire moving around in the fire affected area. There may be opportunities to contain the fire on these flanks and, within the fire effected area, dead edge unbanded fire edges and extinguish fire in peatlands to prevent more peatlands burning. This work may not possible until the bushfire moderates but should be undertaken as soon as safe and resources allow, and may continue for several days or weeks to extinguish peatlands. As machinery becomes available, particular attention must be given to ensure its use is carefully controlled and not used inappropriately.

PLANNING AND INTELLIGENCE

- Continue to implement Work Instruction Work Instruction 5.5.1.X "Management of Alpine Peatlands Values during Fire Response" on Fireweb .
- Distribute through the ISP the one page protocol (accessible through the Work Instruction 5.5.1.X "Management of Alpine Peatlands Values during Fire Response") for crews working on fireground in and around Alpine Peatlands.
- Continue to model fire prediction to identify critical and high alpine peatland areas under threat.
- Investigate peatland dryness conditions to predict likely fire intensity and fire infiltration into profile to forecast longer term burning scenarios.
- Prepare suitable minimum impact suppression tactics for IAP that will steer the fire way from large Alpine Peatland clusters (some may be sacrificed), aiming to contain the flanks of the main fire utilising open treeless areas. FLIR will assist identifying hot edges.
- Prepare suitable minimum impact suppression tactics for IAP that directly attack the fire front to contain to open treeless areas.
- Identify minimum impact suppression tactics to protect locally more highly critical peatlands that have been identified (see Stage 1).
- Identify disconnected clusters of alpine peatland where targeted minimum impact suppression work is feasible and efficient, i.e. a small amount of work may have a high chance of success.
- Utilising tools such as FLIR, identify opportunities to go into the fire affected area to extinguish fire that still threatens unburnt alpine peatlands.
- Utilise the Tree Hazard Work Instruction and mapping layer to determine safe fire-ground crew access to peatlands.
- Prepare fall-back plan using existing tracks and waterbody edges if possible should direct attack fail.
- Consider fall-back positions where suitable resources may be available such as alpine resorts, crews, sprinklers, long hose lines, hand trails, existing track networks etc.
- Evaluate potential of significant weeds and/or pathogens to enter alpine peatlands from fireground activity and take necessary actions to prevent.

STRATEGIES

- Direct air attack on flanks and front to contain fire to dead edges in open treeless areas.
- Halt other unbound fire edges in the fire affected area that may continue to burn into alpine peatlands.
- No off track machinery use in treeless areas (although careful use of soft impact slashing/mulching machinery may be suitable and useful, but not in Alpine Peatlands).
- Prepare fall back lines on existing road network or minimum impact containment line building in robust areas such as wooded ridges where it protects critical peatlands.

TACTICS

- Air attack on the fire flanks and front where possible laying retardant lines to dead edge or slow fire making tactical use of open treeless areas to get retardant directly onto the ground. (see Appendix 1)
- Halt other unbound fire edges in the fire affected area that may continue to burn into alpine peatlands.
- Air attack on running edges in grasslands with water or foam to dead edge.
- Air attack on fire in peatlands burning in fire effected area through dropping water directly into or adjacent to burning peatlands, taking advantage of quick turn-around to water source in nearby waterbodies.
- Where road or track access permits for tankers, run out hose lines to dead edge in grasslands and extinguish fire in peatlands.
- Air lift in collar and/or large tanks, hose lines pumps and crew to remote areas to dead edge and extinguish fire in alpine peatlands.
- Prepare fall back lines on existing road network or minimum impact containment line building in robust areas such as wooded ridges where it protects critical peatlands.

TAKE CARE

- Avoid “burning out” peatlands to containment lines. Dead edge or bring fire to robust wooded areas on ridge lines so crews can deal with fire with hand trails or light touch machinery.
- No off track machinery use in treeless areas. (although careful use of soft impact slashing/mulching machinery may be suitable and useful, but not in Alpine Peatlands)
- Avoid digging within peatlands to extinguish substrate/peat fires.
- As onground work proceeds, consider potential of significant weeds and/or pathogens to enter alpine peatlands from fireground activity and take necessary actions to prevent.

APPENDIX 2 RETARDANTS, FOAMS AND WATER USE IN AND AROUND PEATLANDS

Strategic positioning of retardant lines may be a very useful tactic in contributing to keeping fire out of alpine peatlands and the use of foam may improve the efficiency of water application. However, the direct application of retardants and/or foams into alpine peatlands is unnecessary and should be avoided. The direct effect on peatlands is largely unknown but it's judicious to presume at this stage that the rapid introduction of high nutrient loads and/or chemicals to sensitive ecosystems may have a deleterious effect and would be likely to increase the soluble nutrient load present in the water.

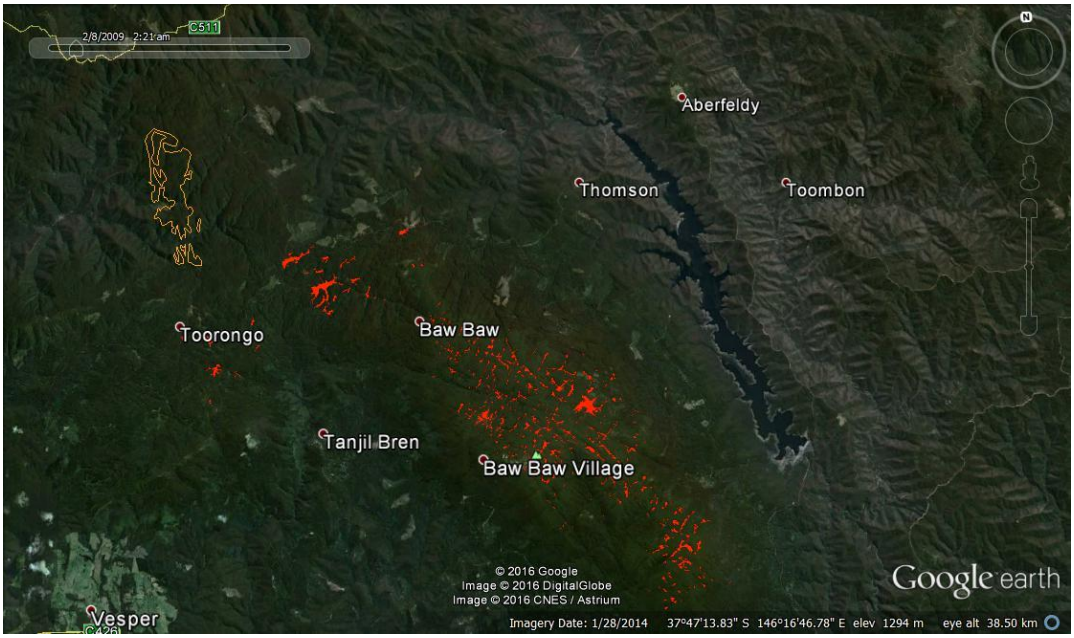
The following should guide the use of retardants, foams and water in and around alpine peatlands;

- Retardant could be used to build lines between the fire edge and alpine peatlands to slow the fire.
- Retardant application should be more than 20 metres from an alpine peatland (preferably further).
- Retardant application should take tactical advantage of treeless grasslands and the edge of snow gum woodlands where the fuel load is lower and less flammable and retardant can be applied directly onto the ground.
- Foam may be used for dead edging and spotting where the fire edge is more than 20 metres from an alpine peatland.
- If the fire is burning in or less than 20 metres from an alpine peatland it should be extinguished using water only (or by handtools if water not available).
- If working close to alpine peatlands with retardant or foam, rotary rather than fixed wing aircraft should be used to increase accuracy of drops and reduce impact of drift.
- As many peatlands are in depressions, tactical use of slope should be considered for line building and dead edging.
- If applying water directly into a peatland by air attack, care should be taken to spread the load lightly to avoid soil and vegetation damage.

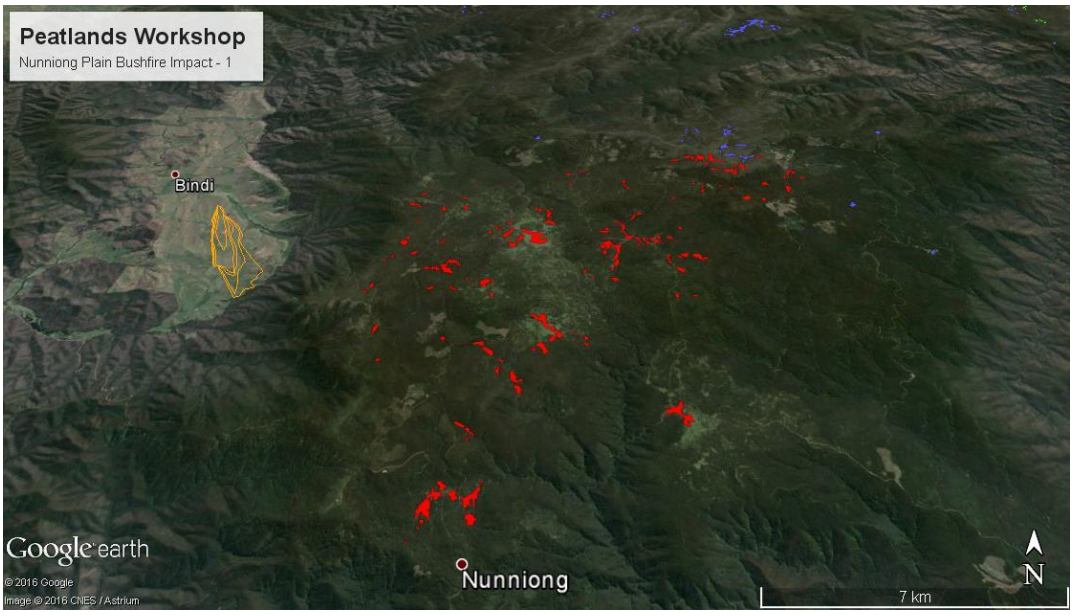
Air attack supervisors should be trained in the identification of peatlands from the air and briefed on appropriate uses of retardants, foams and water in and around alpine peatlands. Tools that assist identification such as in flight access to peatlands data should be considered.

APPENDIX 3 PHOENIX GENERATED SCENARIOS (FFDI 60) USED IN WORKSHOPS

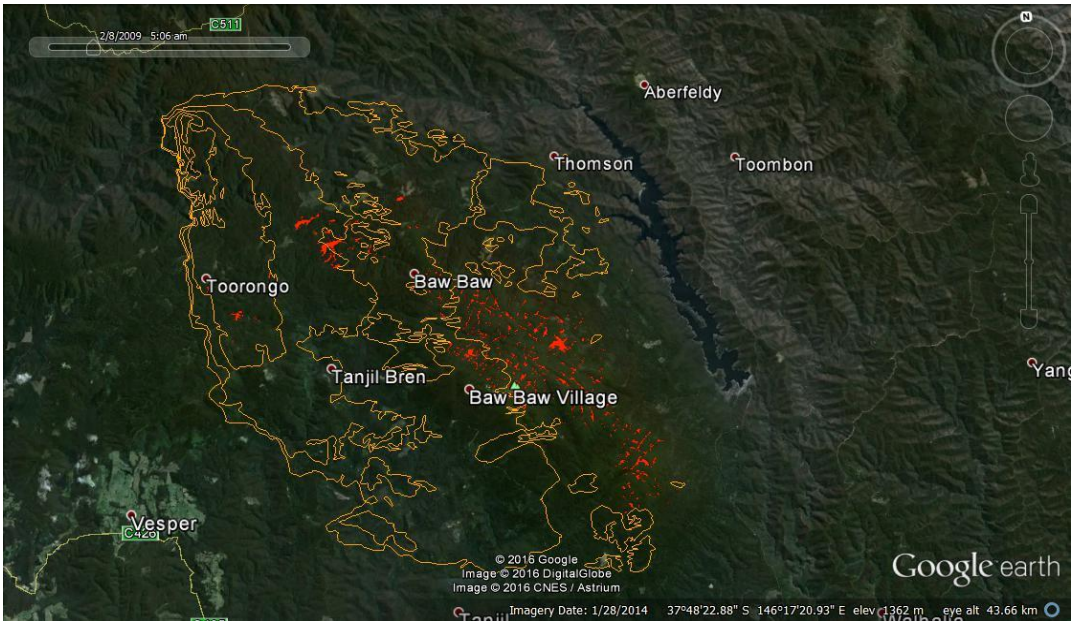
STAGE 1 BUSHFIRE START WITH POTENTIAL TO IMPACT ON CRITICAL ALPINE PEATLANDS (IN RED)



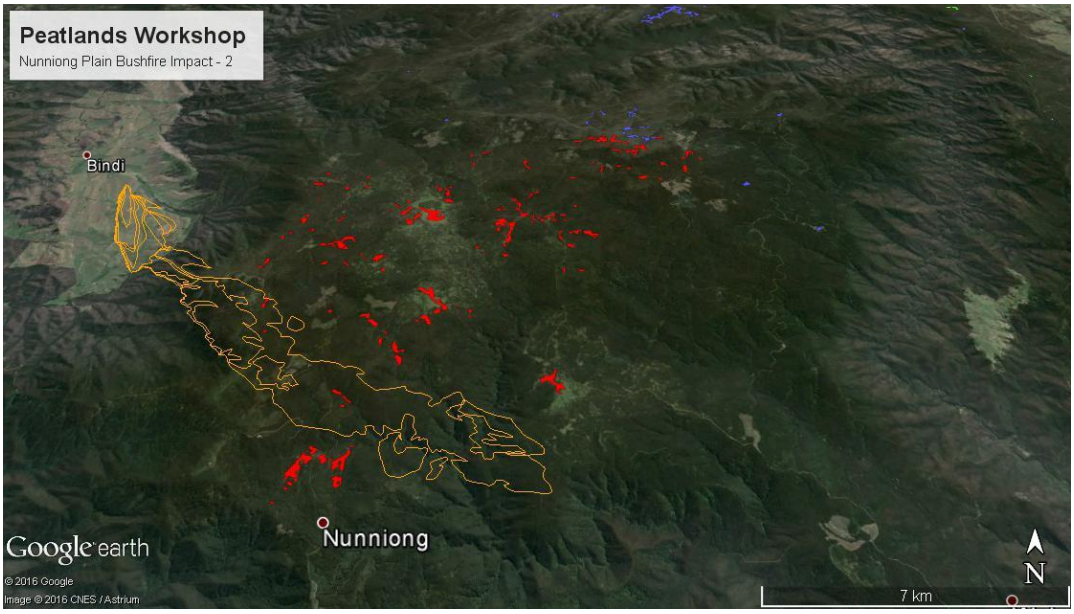
Baw Baw Plateau



Nunniong Plateau

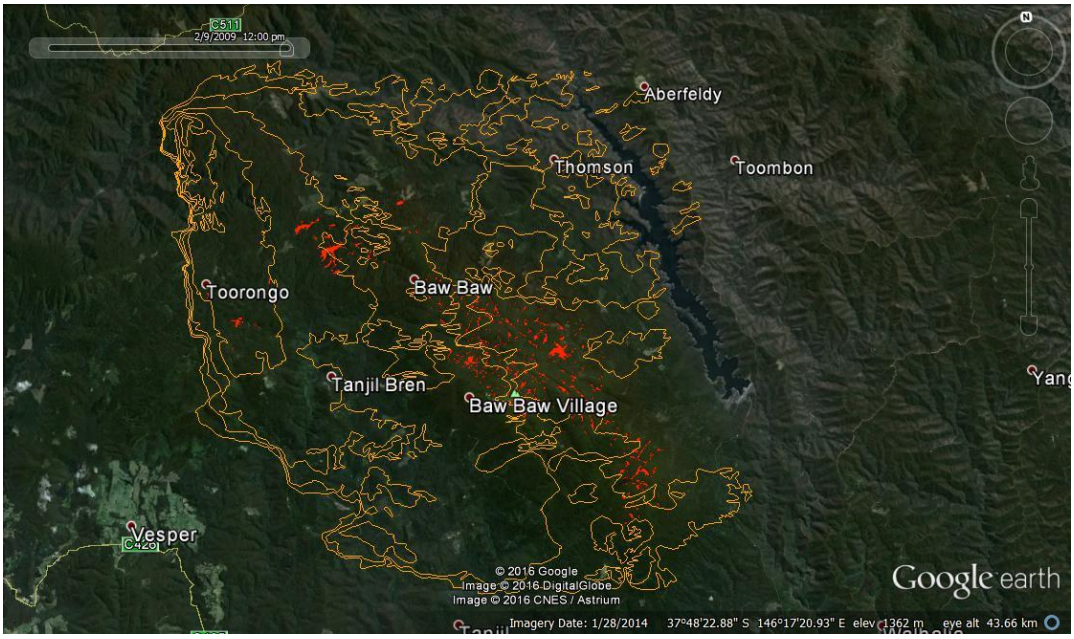


Baw Baw Plateau

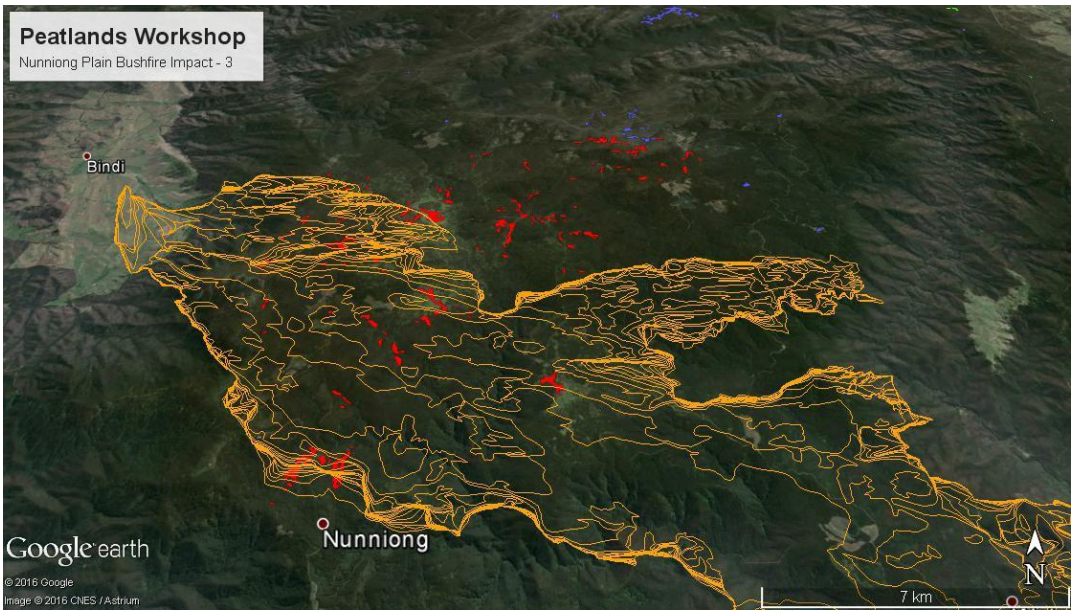


Nunniong Plateau

STAGE 3 BUSHFIRE PASSING THROUGH CRITICAL ALPINE PEATLANDS (IN RED)



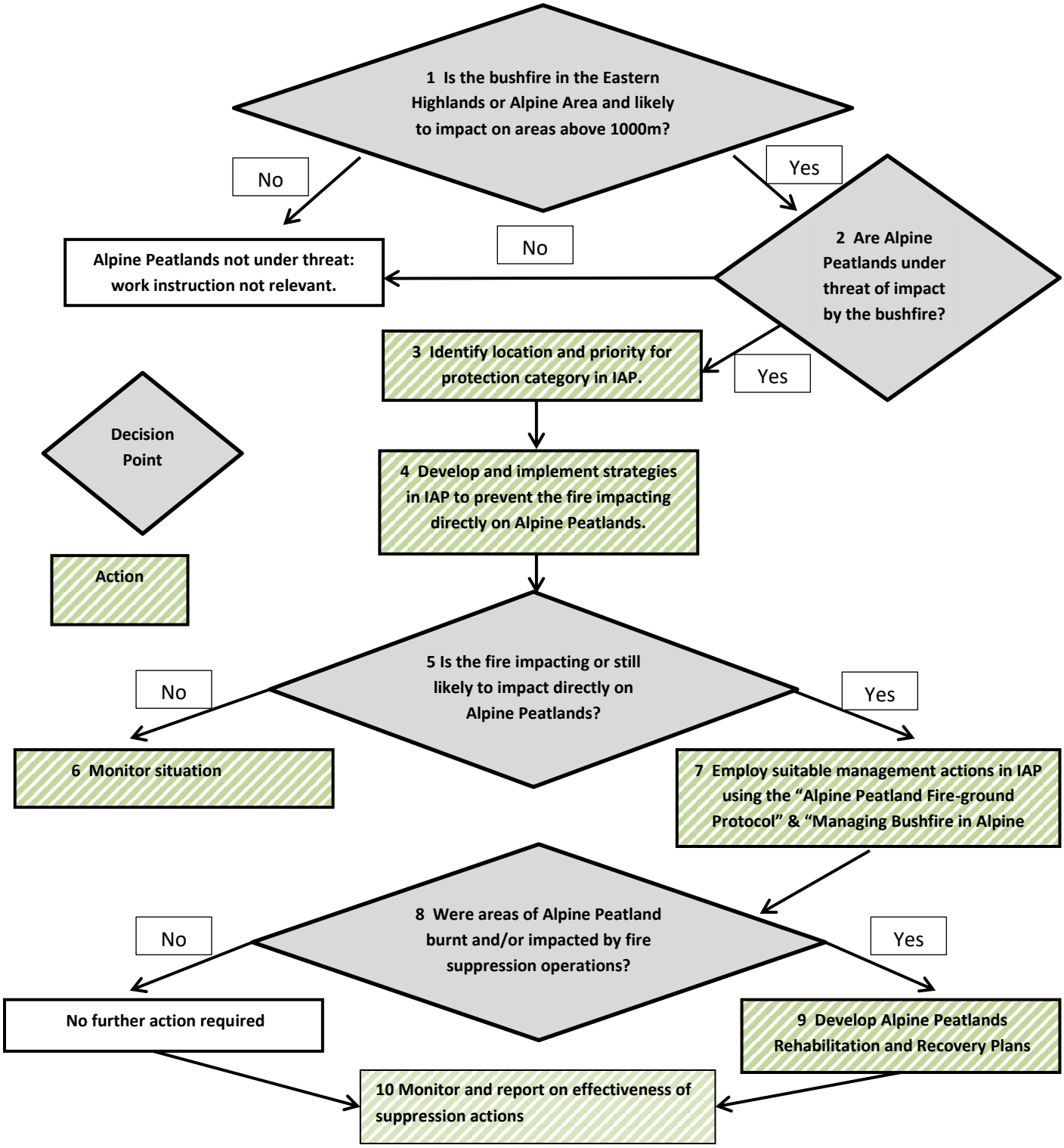
Baw Baw Plateau



Nunniong Plateau

APPENDIX 4 DECISION TREE FROM WORK INSTRUCTION 5.5.1.X

Work Instruction: "Management of Alpine Peatlands Values during Fire Response"



Prioritising alpine peatlands for fire mitigation planning in Victoria

Alpine peatlands on Mount Baw Baw. Photo Anita Wild, Wild Ecology.

Prioritising alpine peatlands using MCAS-S

The Alpine Peatlands Fire Risk Mitigation Planning Project funded by the Australian Government National Landcare Program aims to improve the management efficacy of the 4086 hectares of alpine *Sphagnum* bogs and associated fen communities in the Victorian Alps, by reducing the impacts of fire and fire control activities through development and application of Fire Management Guidelines.

While all peatlands should be protected from the impact of fire and fire suppression operations where possible, this strategic landscape scale prioritisation of peatlands is important to guide fire management and suppression strategies. Factors that influence alpine peatland vulnerability to fire were firstly identified and then combined with other values data to create a map priortising peatlands across alpine Victoria using the MCAS-S tool (ABARES).

The principle was to give the highest priority for protection from fire to those peatlands that provide the best chance of maintaining landscape scale function and resistance stability (ability to resist fire) and protecting high natural and societal values. This will be through retaining, in the long term, the remaining small occurrences and representation of highly functioning peatlands in a relatively undisturbed natural condition and secondly, protecting those most likely to emerge into that condition. These priorities will now guide planning for protection of alpine peatlands.

Project outputs

- A map prioritising alpine peatlands.
- The PeatFire MCAS-S datapack for prioritising alpine peatlands.
- A worked example showing how the prioritisation was conducted and how it can be modified using the PeatFire datapack.
- PeatFire Datapack Quick Guide.
- Literature review of fire effects on peatlands.
- Peatland 'shrubbiness' data layer.
- Predicted percent *Sphagnum* burn for individual peatlands in Victoria data layer.
- Raster data layers used in the prioritisation.
- Report on 'Prioritising Alpine Peatlands for Fire Mitigation Planning in Victoria and MCAS-S datapack'.

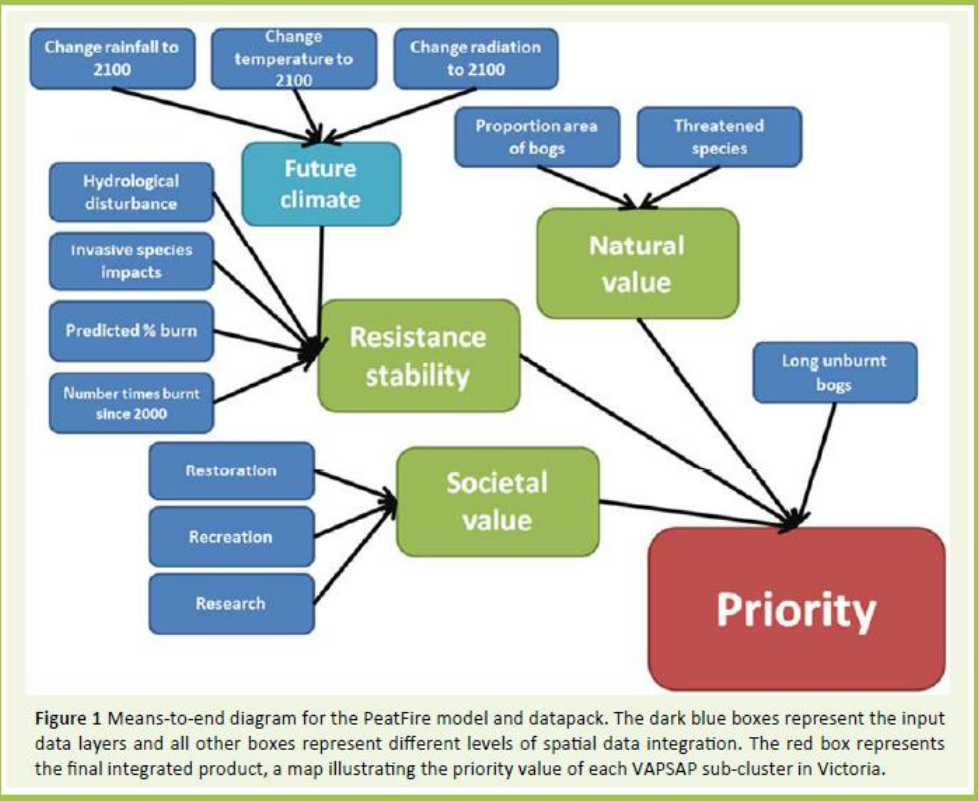


Figure 1 Means-to-end diagram for the PeatFire model and datapack. The dark blue boxes represent the input data layers and all other boxes represent different levels of spatial data integration. The red box represents the final integrated product, a map illustrating the priority value of each VAPSAP sub-cluster in Victoria.

What controls vulnerability of peatlands to fire in the Victorian Alps?

Stage 1 Literature review and analysis of peatland burn severity from the 2003 and 2006/7 fires

An extensive global literature review relevant to fire effects on peatlands across gradients of space and time helped us to develop a conceptual model (Figure 2) that was the basis for selecting variables for the prioritisation.

The relative importance of these variables and the nature of their relationship with burn severity was examined in a landscape scale analysis using existing geographic and field survey data to assess the patterns of fire severity in Victorian alpine peatlands.

The key variables identified as having the greatest influence on peatland burn severity were in order of importance; climate variables (temperature, precipitation), shrubbiness, topographic ruggedness, woodland nearby, size of catchment, common vegetation, topographic position, topographic wetness and shape.

An important output from this stage of the project was a map of predicted percent *Sphagnum* burn for each individual peatland in Victoria if exposed to fire.

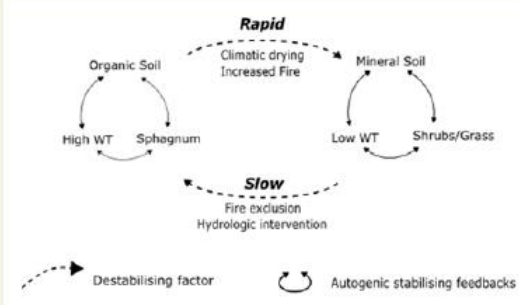


Figure 2 Conceptual model outlining state-shift between organic and mineral soil states. WT=water table.

alpine marsh marigold (*Psychrophila introloba*) Photo Regina Magierowski

Prioritising peatlands using MCAS-S

Stage 2 Generation of a prioritisation map of alpine peatlands in Victoria that could be used in fire mitigation and response planning

Priority values were determined for each sub-cluster in the Victorian Alpine Peatlands Spatial Action Plan (VAPSAP; Figure 3). The principle was to give the highest priority for protection from fire to those peatlands that provide the best chance of maintaining landscape scale function and resistance stability (ability to resist fire) and protecting high natural and societal values (Figure 1). Our map of predicted percent *Sphagnum* burn was combined with data on fire history (recent and long term), impacts of invasive species, future climate (rainfall, temperature and solar radiation), threatened species, area of peatland and societal values (recreation, research and restoration sites associated with peatlands) (Figure 1).

The prioritisation was performed using the Multi-Criteria Analysis Shell for Spatial Decision Support tool (MCAS-S). The basis for the prioritisation were the results from Stage 1 of the project and the expert opinion provided by Anita Wild, Arn Tolsma, Marie Keatley and Dick Williams. After consultation with peatland experts and staff from Parks Victoria a four category classification was considered to be the most useful for the ongoing stages of the Alpine Peatlands Fire Risk Mitigation Planning Project. The categories from high priority to lowest were: 'Critical', 'High', 'Moderate' and 'Lowest'.

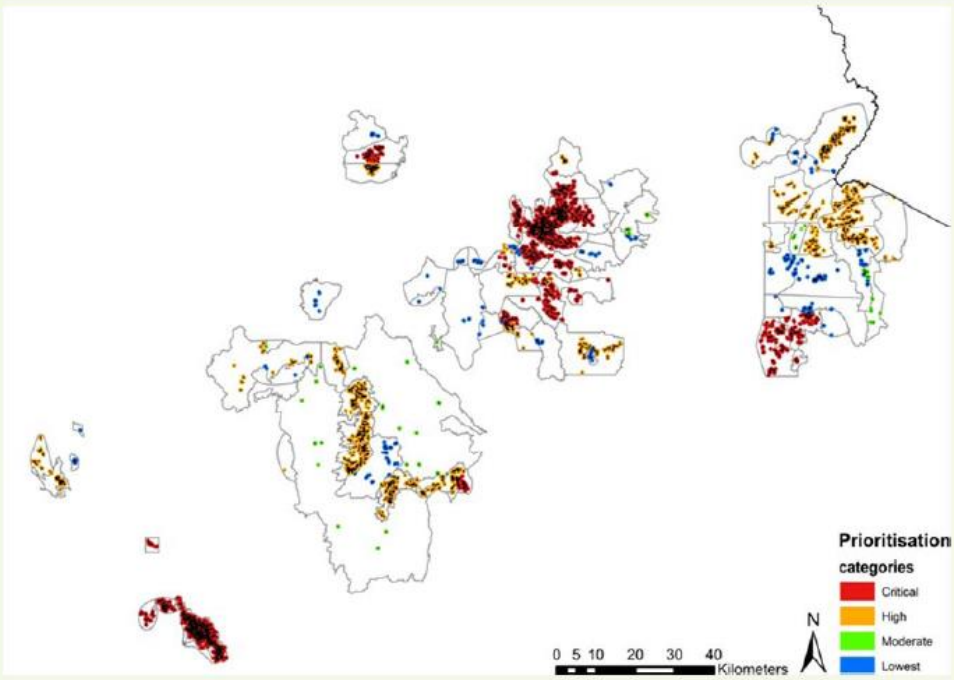


Figure 3 Map showing the final prioritisation of Victorian alpine peatlands for fire risk mitigation planning. Priority levels are red='Critical' priority, orange='High' priority, green='Moderate' priority and blue='Lowest' priority. Alpine peatlands (black) buffered to 500m (coloured areas) to enhance interpretation of the map. Priority was determined at the scale of VAPSAP sub-clusters (grey lines).

Pretty Valley
Photo Regina Magierowski

Acknowledgments

Report prepared by
Dr Regina Magierowski, Dr Anita Wild and Peter Jacobs.

What controls vulnerability of peatlands to fire in the Victorian Alps?
Ben French, Dr Grant Williamson and Prof David Bowman, School of Biological Sciences, University of Tasmania.

Prioritising peatlands using MCAS-S
Dr Regina Magierowski and Dr Anita Wild, School of Biological Sciences, University of Tasmania.

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For help with MCAS-S or to organise a tutorial contact ABARES - land_management@agriculture.gov.au

Alpine peatlands expert panel
The authors are grateful for the generous assistance and expert advice provided by Wild Ecology, Arn Tolsma (Arthur Rylah Institute), Dick Williams (consultant) and Marie Keatley (Parks Victoria). Special thanks also for assistance with the prioritisation and acquisition of data layers to Dan Jamieson (Parks Victoria), Stephen Deed (Department of Environment, Land, Water & Planning) and Ty Caling (Parks Victoria).

The Victorian Alpine Peatland Protection Program is an initiative jointly funded through Parks Victoria, the West Gippsland Catchment Management Authority and the Australian Government's National Landcare Programme (via the North East, West Gippsland and East Gippsland Catchment Management Authorities).

APPENDIX 6 SUMMARY REPORT OF STAGE 3

Fire modelling in alpine peatlands for fire mitigation planning in Victoria

Bogong High Plains 18th February 2003. Photo DELWP

The Alpine Peatlands Fire Risk Mitigation Planning Project funded by the Australian Government National Landcare Program aims to improve the management efficacy of the 4086 hectares of alpine *Sphagnum* bogs and associated fen communities in the Victorian Alps, by reducing the impacts of fire and fire control activities through development and application of Fire Management Guidelines.

Stage 3 uses Phoenix RapidFire to model bushfires to determine where the risks to priority Alpine Peatlands are most likely and to assess the effectiveness of a range of hypothetical and practical fuel treatment options using planned burning. New methods have been developed specifically for this analysis and will provide input and recommendations into Strategic Bushfire Management Plans being developed by DELWPs Bushfire Risk Landscape Teams.

- At a landscape scale nine treatment options were assessed against twelve historical weather scenarios
- Recommendations made for each peatland areas within the ctiical and high classes

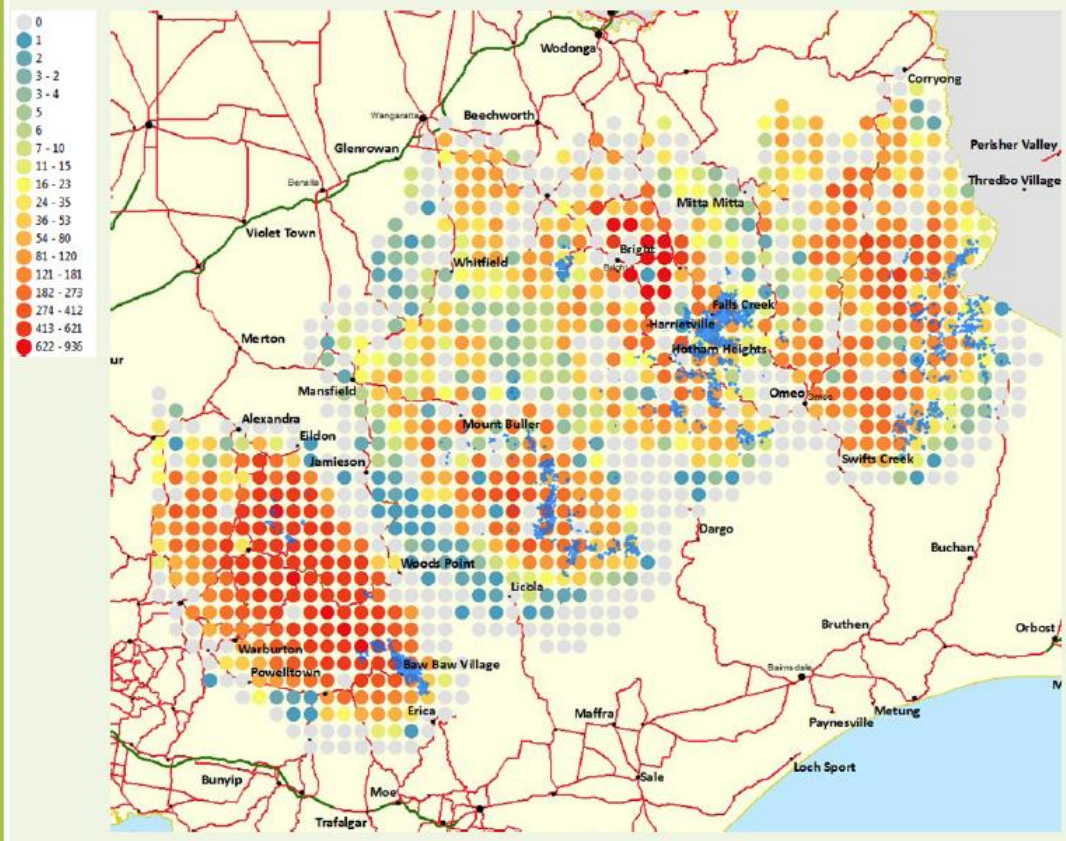


Figure 1 Fire Catchments showing ignitions from a 5km grid that impact on peatland. The area of peatland impacted by each ignition is colour coded. (If a fire started at that location it could burn this many hectares of peatland)

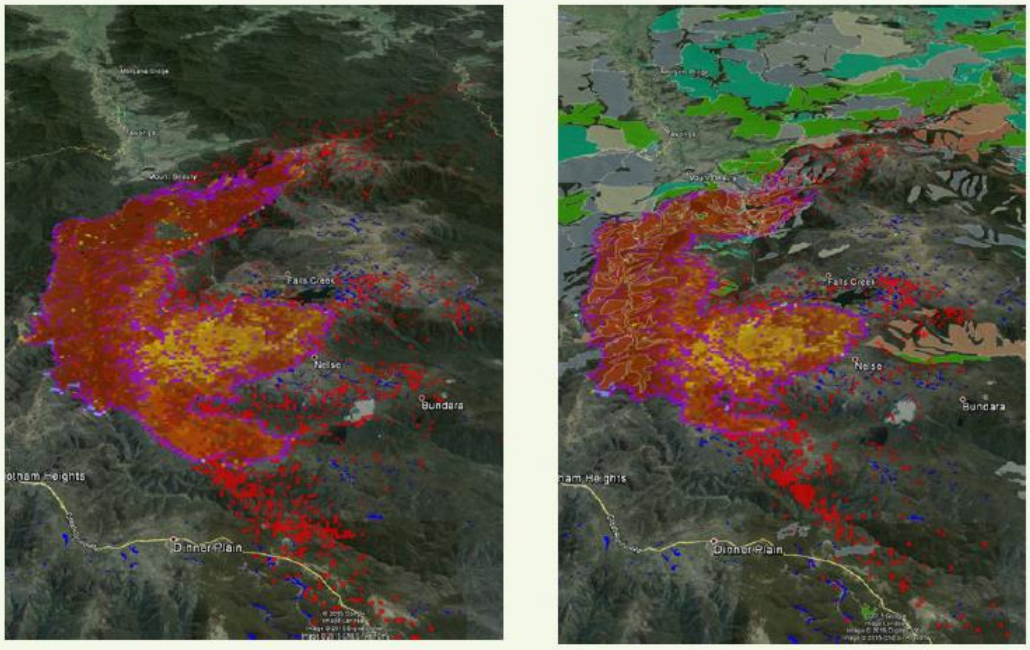


Figure 2 Treatment vs non treatment Bogong High Plains

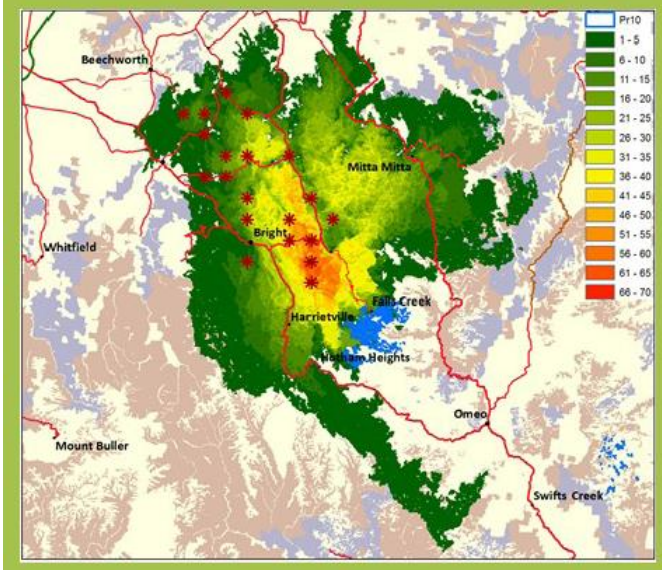
Fens—Newlands Road Baw Baw Plateau . Photo Owen Salkin.

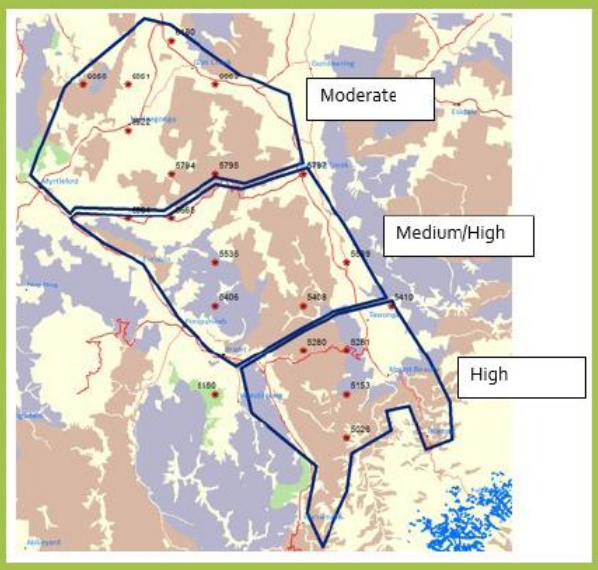
Modelling outcomes

Stage 3

The modelling has shown that

- Phoenix can be used to identify the locations of worst ignitions and the parts of the landscape where fires progress and impact on peatland areas.
- Phoenix can be used to assess the effectiveness of strategies aimed at protecting peatland.
- In general bushfire threats to peatland are greatest from fires that have a path that progresses from outside toward the alpine areas. This enables the fire to gather momentum and create higher intensities that can encroach onto peatland areas.
- At a landscape scale planned burning does mitigate risks to peatland but is more effective in some areas than others.
- The proposed fuel treatments in the Strategic Bushfire management Plan (SBMP) result in reduced risk, however significant risks remain on extreme and greater fire danger days
- Planned burning does not improve protection of many peatland areas as they are surrounded by large areas unsuitable for planned burning. Any risk mitigation for these areas can only be achieved may kilometres distant and would generally be part of broader landscape burning or for protection of other specific assets.
- Modelling suggests peatland impacts are moderate when fire danger conditions are below high. In the past 6 years the only day of major threat was Black Saturday (February 7th 2009).
- Potentially impacting days only occur in January and February
- Analysis of current zoning and burning frequencies suggest that some improvements could be made to increase peatland protection but that other environmental values and the likelihood of the threat would need to be considered by managers.





6th December 2006 Great Divide Fire from Mt Buller . Photo DELWP.

Acknowledgments

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Phoenix Rapidfire model— DELWP, Melb Uni, Bushfire CRC

The Victorian Alpine Peatland Protection Program is an initiative jointly funded through Parks Victoria, the West Gippsland Catchment Management Authority and the Australian Government's National Landcare Programme (via the North East, West Gippsland and East Gippsland Catchment Management Authorities).

APPENDIX 7 FIRE AND PEATLAND STRATEGY AND TACTICS WORKSHOPS

Workshops were held to explore potential strategies and tactics for response and suppression that may be employed to mitigate the impact of bushfire on Alpine Peatlands.

The workshop details are:

Date2016	**Location**	**Attendance**
23 February 1100-1230	Ovens DELWP	20
25 February 1000-1130	Traralgon	7
26 February 1000-1130	Bairnsdale	6
21 March 20161400-1530	Orbost	4
Total		**38**

The workshops agenda included

- The PPRR approach
- Discussion around Response to three Phoenix generated bushfire scenarios (FFDI 60)
    - Potential threat
    - Active fire in Alpine Peatlands
    - Fire front passed
- Accessibility, placement and format of guidelines/instructions

APPENDIX 8 SUMMARY OF COMMENTS AND RECOMMENDATIONS ON PLANNED BURNING

Recommendations and observations from "Analysis of Fire Behaviour and Scenario Modelling of Planned Burning Regimes to mitigate impacts on Alpine Peatlands": Natural Systems Analytics 2015. Risk Reduction Summaries and Actions by VAPSAP Cluster (McMahon, A et.al, 2012) and Priority Classes (UTAS 2015)

Fire Risk Landscape: East Central

Cluster Name	Priority Class	Comments and Recommendations on planned burning options
The Oaks	10	Protection may be improved with higher frequency planned burning of adjacent LMZ, however much of this is alpine ash. Proposed BMZ PFMA in the SBMP theoretically adds protection but again alpine ash and wetter forest would need to be treated.
Toorongo	10	Refer Example 3 (Baw Baw) in report for detailed analysis and recommendations. Surrounded by untreatable areas and even high frequency burning of LMZ results in around 60% residual risk. Existing and SBMP treatments result in around 80% residual risk however this is predicated by being able to treat significant areas of moderate (1 in 5 years) treatability.
West Tanjil	10	
Thomson River	10	
Cascade Creek	10	
Tanjil River	10	
Tyers River	10	
Baw Baw Resort	10	
Newlands	9	As with adjacent priority 10 areas residual risk can only be reduced to around 60% with a theoretical intensive treatment. At best, with existing zoning or that proposed in the SBMP the risk may only be reduced to around 80%.
Thomson River - State Forest	9	
Tanjil River - State Forest	9	
Blue Range	6	Although no data was supplied for Blue Range the comments for Lake Mountain should cover the same range of considerations. Treatments have little impact with residual risk remaining above 70%. Impacting fires start within or adjacent to the ash forests and may travel up to 40km before impacting.
Lake Mountain	6	

Fire Risk Landscape: Alpine & North East

Cluster Name	Priority Class	Comments and Recommendations on planned burning options
Pretty Valley	10	Refer Example 2 (Bogong High Plains) in report for detailed analysis and recommendations. There are areas of LMZ within the fire catchment that would provide greater protection if the frequency of burning were increased. Some benefit may also be gained by increasing the frequency in existing BMZ. Areas of LMZ to be treated should focus on areas that are both contiguous and closer to the peatland for the greatest benefit however areas further away do influence risk, but to a lesser extent. Detailed examination suggested that 95% of the fire threat came from the very bad fire weather such as experienced on Black Saturday.
Heathy Spur	10	
Buckety Plain	10	
Young's Top West	10	
Falls Creek Resort	10	
Buffalo Central	9	Refer **Error! Reference source not found.**) in report for detailed analysis and recommendations. The existing treatment of BMZ on the lower slopes of the mountain significantly reduces risk. It is also possible that additional areas of BMZ to the west and south west also contribute. Increases in proposed frequency under consideration in the SBMP result in slightly increased risk but may represent a more balanced approach that considers other values.
Mount Fainter	9	As with adjacent Priority 10 peatlands the highest impacting ignitions originate in the Tawonga Gap and Harrietville areas and there is also an opportunity to improve protection if LMZ were treated more frequently. This is most relevant to the Hotham Resort, Mount Fainter and Nelse North areas.
Nelse North	9	
Wild Horse	9	
Hotham Resort	9	
Buffalo South	8	As with other Buffalo examples the treatment of adjacent BMZ is the largest driver in reducing risk
Mount Bogong	6	Risk reduction influenced by both BMZ and LMZ. Ignitions occurring between Mitta Mitta and Tawonga appear to be of the greatest threat.
Mt Loch	5	See comments for Priority 10 - Pretty Valley, Buckety Plain, Young's Top West, Falls Creek Resort and Heathy Spur. Risk reductions appear driven by the same issues of BMZ and LMZ in the predominant fire path NNW of the Great Divide.
Jones Creek	5	

Fire Risk Landscape: Alpine & Gippsland

Cluster Name	Priority Class	Comments and Recommendations on planned burning options
Nunniong Plateau West	10	The fire catchment for these peatlands is large, however treatments proposed should focus on areas south and west of the Omeo Benambra Road. Frequencies proposed in the SBMP provide good protection. A possible improvement may be to increase frequencies around Bindi.
Nunniong Plain NFSR	10	
Nunnett Plain NFSR	10	
Nunniong Plateau Central	9	
Bentley Plain NFSR	10	
Little River	9	Fire threats for this peatland area are from the north and northwest. Changes in frequency of BMZ do not appear to change the risk, however changes to the LMZ frequency have potential to reduce risk. The SBMP frequency of 35 years reduces risk to 66%.
Dinner Plain Track	9	As with adjacent Priority 10 peatlands the highest impacting ignitions originate in the Tawonga Gap and Harrietville areas and there is also an opportunity to improve protection if LMZ were treated more frequently.
Dargo HP	9	
Victoria River	9	
Dinner Plain private	9	These results have not been included as they indicate that treatment may marginally increase risk. This may be the case or it may be due to the small areas involved and lack of adjacent treatability.
Young's Top East	9	
Howqua	6	Howqua Peatland benefit from the adjacent BMZ burning and also from LMZ burning.
Howitt Plains	8	The Howitt Plains are the only one of these 3 clusters to be influenced by changes in BMZ frequency – it is surmised that BMZ near Howqua and Jamieson is influencing this. Current and SBMP appear to provide good protection for this area. The risk in the Tamboritha and Moroka areas appear directly linked to the amount of LMZ burning – consideration could be given to frequencies in the adjacent LMZ ranging from 25 – 50 years but more detailed analysis would be require to identify exactly where.
Tamboritha	8	
Moroka - State Forest	8	
Dinner Plain National Park	8	There is little treatable area in the vicinity of these peatlands so changes to fire risk is influenced by treatments some distance away. Generally some level of treatment at lower elevations to the north of these locations in either BMZ or LMZ can reduce the risk. Note: Calculations of residual risk indicate that treatment results in higher risk for the Flourbag Private sub cluster – while this could be the case it may be a result of the ignition grid resolution and the very small area of peatland in this location –
Flourbag private	8	
Dargo HP private	8	

		what may be inferred is treatment may have little impact.
Davies Plain	8	It is important to note that this analysis has not considered the fire risk from New South Wales and focusses solely on Victorian ignitions and fire paths. No fuel data is yet available for NSW. In the case of Davies Plain and, the significant amount of BMZ within the fire paths appears to reduce the risk of faraway fires reaching the peatlands. For Rocky plains, the immediately adjacent BMZ appears to reduce risk. Both Playgrounds and Cowombat appear only influenced by the LMZ treatments. The SBMP generally provides good protection however strategies developed should consider both the ANE and AGG BRLs and NSW
Cowombat	8	
Playgrounds	8	
Rocky Plains	8	
Bryces Plain	7	All 3 peatland areas are only influenced by LMZ burning and not BMZ burning. The worst ignitions are generally within 20kms of the peatlands (West and North-west) but there are some long range threats from as far away as Lake Cobbler and Lake William Hovell. The 1998 and 2006/07 fires may also provide insight into where the threats have come from.
Snowy Range	7	
Wellington	7	
Native Cat	7	The greatest threats arise south of the Great Divide within 10-15km to the north of these areas. The existing BMZ appears very effective in reducing fire risk.
Upper Tambo private	7	
Limestone Creek private	7	
Macalister - State Forest	6	These other three peatland areas are only influenced by LMZ frequency. Fire threats are greatest in a North to West to South-South East arc to a distance of 25-30km.
Shaws Creek	6	
Moroka	6	
Young's Top - State Forest	6	Treatment has negligible impact on Young's Top whereas the frequency of treatment of both adjacent LMZ and BMZ reduce fire risk. Fire threats are greatest in a North to West to South-South East arc to a distance of 20-25km. Areas of BMZ and LMZ within Alpine and Greater Gippsland contribute to protection.
Butcher Creek	6	
Buenba National Park	6	The major fire threats to Buenba National Park and Limestone peatland areas arise on or north west of the Great Divide. Hence both LMZ and BMZ have roles to play in reducing risk. Suggan Buggan is largely influenced by the adjacent LMZ and this provides little risk reduction. The impact of fires from NSW has not been considered.
Limestone	6	
Suggan Buggan	6	
Dead Horse Creek	5	Fire threat for this area is generally greatest east of the Omeo Highway and impacting fires can cover considerable distance (some bad fires come from as far away as Bucheen Creek). The existing zoning and that proposed in the SBMP provides good levels of protection.

APPENDIX 9 ALPINE PEATLANDS AND PRIORITY CATEGORIES FROM EMAP.