



Australian Government  
Department of the Environment

# National Recovery Plan for the Alpine *Sphagnum* Bogs and Associated Fens

- a threatened ecological community listed under the  
*Environment Protection and Biodiversity Conservation Act 1999*



November 2015

Prepared by: Department of the Environment

Made under the *Environment Protection and Biodiversity Conservation Act 1999*

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Note: This recovery plan sets out the actions necessary to stop the decline of, and support the recovery of, a listed threatened ecological community. The Australian Government is committed to acting in accordance with the plan and to implementing the plan as it applies to Commonwealth areas. The plan has been developed with the involvement and cooperation of a broad range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds are subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

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This plan should be cited as:

Department of the Environment (2015) *National recovery plan for the Alpine Sphagnum Bogs and Associated Fens ecological community*. Department of the Environment, Canberra.

NATIONAL RECOVERY  
PLAN FOR THE ALPINE  
*SPHAGNUM* BOGS  
AND ASSOCIATED  
FENS

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## Acknowledgements

The Department of the Environment is grateful to the organisations and individuals who contributed to or provided information for the preparation of this recovery plan and have been or are still involved in implementing conservation and management actions that benefit the Alpine *Sphagnum* Bogs and Associated Fens ecological community.

In particular, the Department acknowledges researchers and conservation experts, including academics, non-government organisations, Commonwealth, State, and Territory Government staff, and the Steering Committee, established to contribute to and provide advice on the preparation of the Alpine *Sphagnum* Bogs and Associated Fens recovery plan. The Steering Committee comprised representatives of the New South Wales, Tasmanian, Australian Capital Territory and Victorian governments, as well as Wetlandcare, and independent experts in the ecological community. The views expressed in this document do not necessarily represent the views of the members of the Steering Committee or the agencies they represented.

### Acknowledgement of Traditional Owners and Country

The Australian Government acknowledges Australia's Traditional Owners and pays respect to Elders past and present. We acknowledge the deep spiritual, cultural and customary connections of Traditional Owners to the Australian alpine landscape, including the Alpine *Sphagnum* Bogs and Associated Fens.

# Contents

Acknowledgements .....	iv
<b>1. Introduction .....</b>	<b>2</b>
<b>1.1 Objectives.....</b>	<b>2</b>
<b>1.2 Legislative context.....</b>	<b>2</b>
<b>1.3 Affected interests and potential contributors.....</b>	<b>4</b>
<b>1.4 Biodiversity impacts and benefits.....</b>	<b>5</b>
<b>2. The ecological community.....</b>	<b>6</b>
<b>2.1. Description.....</b>	<b>6</b>
<b>2.2 Flora .....</b>	<b>6</b>
<b>2.3 Fauna .....</b>	<b>7</b>
<b>2.4 Ecology (including hydrology).....</b>	<b>8</b>
<b>3. Distribution .....</b>	<b>10</b>
<b>3.1 Important occurrences.....</b>	<b>10</b>
<b>3.2 Areas of the ecological community under particular pressure for survival .....</b>	<b>10</b>
<b>4. Threats.....</b>	<b>15</b>
<b>4.1 National severity rating .....</b>	<b>15</b>
<b>4.2 Climate change .....</b>	<b>16</b>
<b>4.3 Fire .....</b>	<b>17</b>
<b>4.4 Domestic stock .....</b>	<b>17</b>
<b>4.5 Invasive Species - Fauna.....</b>	<b>18</b>
<b>4.6 Invasive species - Flora.....</b>	<b>19</b>
<b>4.7 Pathogens and Diseases .....</b>	<b>20</b>
<b>4.8 Infrastructure, development and recreation.....</b>	<b>21</b>
<b>4.9 Resource use .....</b>	<b>21</b>
<b>5. Recovery Programme .....</b>	<b>22</b>
<b>5.1 Objectives.....</b>	<b>22</b>
<b>5.2 Strategies .....</b>	<b>22</b>
<b>5.3 Performance criteria .....</b>	<b>23</b>
<b>5.4 Recovery Actions .....</b>	<b>25</b>
<b>6. Implementation.....</b>	<b>38</b>
<b>6.1 Projected funding needs and timing .....</b>	<b>38</b>
<b>6.2 Monitoring, evaluation, reporting and review .....</b>	<b>42</b>
<b>6.3 Guide for decision makers .....</b>	<b>42</b>
<b>7. References .....</b>	<b>43</b>

# 1. Introduction

The primary purpose of the Alpine *Sphagnum* Bogs and Associated Fens recovery plan is to provide the research and management actions necessary to stop the decline, and support the recovery of, the ecological community so that the chances of its long-term survival in nature are maximised. A major focus of this plan is to address the key threats affecting the ecological community.

The Alpine *Sphagnum* Bogs and Associated Fens ecological community has a limited distribution which is scattered throughout a wide range. Although the ecological community can form extensive interconnected networks across large plains, it is considered naturally discontinuous, and occurs in gullies, depressions and cold air drainage areas. The ecological community is found in permanently wet sites in high rainfall alpine, sub-alpine and montane areas of NSW, ACT, Victoria and Tasmania. The majority of examples of this ecological community are found in areas under conservation related tenure, usually in national parks. Therefore, this recovery plan is intended as a key resource for park management agencies, to guide and assist actions to support the recovery of the ecological community. Ideally, the priority actions identified in this plan will be incorporated into future versions of park management plans, and other key management plans, such as those for relevant state forests, and plans dealing specifically with key threats to the ecological community, such as management of feral horses.

The Recovery Plan is also intended to support decision making for environmental regulation and Alps natural resource management, including the allocation of resources.

This recovery plan summarises information that is necessary to support funding and on-ground implementation actions for the recovery of the ecological community across its full national range. The plan includes the key requirements for a recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The recovery plan complements the information provided in the [Commonwealth Listing Advice on Alpine \*Sphagnum\* Bogs and Associated Fens](#) and the [Commonwealth Conservation Advice on Alpine \*Sphagnum\* Bogs and Associated Fens](#).

Supporting information has been compiled in the accompanying document: [Background information for the Alpine \*Sphagnum\* Bogs and Associated Fens National Recovery Plan](#).

## 1.1 Objectives

The primary objective for the Alpine *Sphagnum* Bogs and Associated Fens recovery plan is to:

**Maintain or extend the current known extent (area) and maintain or improve the condition of the Alpine *Sphagnum* Bogs and Associated Fens ecological community over the life of the recovery plan.**

The supporting objective of the plan is to:

**Ensure effective and adaptive implementation of the plan.**

Priority recovery strategies, priority recovery actions and performance criteria to achieve these objectives are set out in *Section 5: Recovery Programme*.

## 1.2 Legislative context

This is the first national recovery plan for the Alpine *Sphagnum* Bogs and Associated Fens ecological community (referred to within this plan as the ecological community on occasion), which is listed as a threatened ecological community under the EPBC Act.

## National status

The ecological community was listed as **endangered** under the EPBC Act in January 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.

Listing under national legislation means that any new or intensified activities that may have a significant impact on the ecological community may require referral and approval under the EPBC Act.

Other relevant national policies and resources for this ecological community include the [Alpine \*Sphagnum\* Bogs and Associated Fens Policy Statement 3.16](#), and the [Commonwealth listing and conservation advices on Alpine \*Sphagnum\* Bogs and Associated Fens](#).

## Conservation status in state and territory jurisdictions

The ecological community is either wholly or partially protected in each State and Territory in which it occurs.

### *Australian Capital Territory*

The community is represented within a single ecological community described in the ACT and mapped by Hope *et al.* (2009). The *Sphagnum cristatum* Montane and Subalpine Bogs (*Sphagnum* Montane and Subalpine Bogs), lie entirely within Namadgi National park and are considered adequately conserved in the ACT (Sharp *et al.*, 2007; G. Hope pers. comm., 2014). Protection and management of the described community occurs through implementation of the Namadgi National Park Plan of Management, the Ginini Ramsar Site Plan of Management, the Strategic Bushfire Management Plan 2004 and the ACT Bushfire Operational Plan. A plan of management for bogs and fens synonymous with the EPBC-listed ecological community is in preparation (ACT Government, in prep).

### *New South Wales*

In NSW, the ecological community is protected under the *Threatened Species Conservation Act 1995* (TSC Act), as a component of a broader endangered ecological community called “Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions”. The ecological community in the NSW Snowy Mountains has been mapped by Hope *et al.* (2012).

### *Victoria*

Two components of the ecological community have been listed as threatened under the *Flora and Fauna Guarantee Act 1988* (FFG Act). These are the ‘Alpine Bog Community’ and the ‘Fen (Bog Pool) Community’ (VSAC, 1991a; 1991b). The ‘*Psychrophila introloba* Herbland Community’ (formerly *Caltha introloba*), also listed under the FFG Act, may also be found within or abutting *Sphagnum* bogs, particularly around areas of late-lying snow (VSAC, 1992; VDSE, 2007). The ecological community in Victoria has been mapped by Lawrence *et al.*, (2009) and Tolsma unpublished (2012).

### *Tasmania*

‘*Sphagnum* peatland’ is listed as ‘Rare’ under the *Nature Conservation Act 2002* (NC Act). The Act specifies that there can be no clearance or conversion of listed communities without a certified Forest Practices Plan. This means that it cannot be cleared or converted unless exceptional circumstances have been approved by the Forest Practices Authority (FPA, 2011). A high proportion of the ecological community is located within National Parks and the World Heritage Areas of Tasmania.



### 1.3 Affected interests and potential contributors

The ecological community is an integral component of the catchments, and catchment hydrology, of the Australian Alps and Tasmanian highlands.

The water yields from the Alps Australian mainland catchments are valued at about \$9 billion annually to the Australian economy (agriculture, hydroelectricity and drinking water supply) (Worboys *et al.*, 2011). This economic value lies partly in the ecological community's role in regulating and filtering water flows to the major rivers of the Murray Darling system. As such, the health, function and productivity of the ecological community are of importance to the national interest.

Specific stakeholders listed below may be affected by the recovery plan's implementation as they own or manage (or may otherwise influence management of) relatively large areas of land on which the ecological community may occur. These parties have a role in the implementation and coordination of recovery actions, particularly across the different land tenures. The major affected interests are:

- National Parks, State Forests and other public land management agencies
- Organisations operating in National Parks and State Forests
- Private landholders
- Traditional Owners.

Non-Commonwealth government organisations and individuals are encouraged rather than bound by or obliged to implement the actions under this plan.

There are a number of other parties with interests in the National Parks where the ecological community occurs. These include: ski resort operators, recreation interests, electricity providers, roads and transport infrastructure agencies, and communications companies. It is necessary for these operators to fully understand their obligations to avoid significant impacts to the ecological community, and to act consistently with the actions outlined in this plan, particularly section 6.3 – guide for decision makers.

#### Indigenous knowledge, role and interests

Compared to other areas of Australia, Aboriginal history across the Alps is still quite poorly understood (Context, 2014).

Evidence from archaeological sites suggests Aboriginal peoples continuously visited or inhabited the alpine and sub-alpine regions from at least 21,000 years ago (Flood, 1980). Many groups maintain strong cultural links and interest in the area today including the Ngunnawal, Wiradjuri, Warundjeri, Ngarigo, Monaro Ngarigo, Wolgalu, and the Taungurung peoples. Wiradjuri, Wolgalu and Ngunnawal are known by their own totems but are acknowledged through the matrilineal bloodline of the Monaro Ngarigo peoples. Many other clans also have associations with the mountains (NSW DEC, 2006).

On the mainland, most of these traditional owner groups share representation on the Australian Alps Traditional Owners Reference Group, where Traditional Owners engage with other land managers in the Alps through the Australian Alpine Liaison Committee. Discussion in 2014 with members regarding the significance of the ecological community to their people suggested that the wetland and bogs areas in the Australian Alps were likely used historically for food gathering and cultural activities.

Traditional Owners were highly aware of the threats faced by the ecological community and the Alps more broadly, and were supportive of the implementation of actions to protect the Alpine *Sphagnum* Bogs and Associated Fens. It was acknowledged that significant sites known to the Traditional Owners were also at risk from many of the same threats: in particular, fires, grazing and trampling. Opportunities for Traditional Owners to contribute to management of the ecological community were strongly supported by the reference group.



## 1.4 Biodiversity impacts and benefits

The ecological community is known to provide significant habitat for a number of endemic and threatened flora and fauna species. The persistence of this ecological community is likely to be critical to the survival of a number of these species.

*Sphagnum* vegetation and the underlying peat organosols have a significant water-holding capacity, which is important in modulating water flow and maintaining the hydrology of surrounding environments (Ashton and Williams, 1989). 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 (Good, 1992). Intact areas of *Sphagnum* act as a natural filter for nutrients, pathogens and sediments, thus, playing an important role in maintaining water quality throughout catchments (McDougall, 1989).

The ecological community occurs as part of a mosaic of alpine and subalpine communities with close hydrological and ecological connections. By necessity and cost effectiveness, the management of threats such as fire and exotic fauna are likely to be enacted at a landscape scale with benefits for the full range of catchment flora and fauna.

## 2. The ecological community

### 2.1. Description

The Alpine *Sphagnum* Bogs and Associated Fens ecological community occurs across alpine, sub-alpine and montane landscapes of Tasmania, Victoria, New South Wales and the Australian Capital Territory in permanently wet areas, such as along streams, drainage lines, valley edges and valley floors. The ecological community also occurs on slopes where soils are waterlogged (Slattery, 1998; Costin *et al.*, 2000). The key to bog formation is a good supply of groundwater and an impeded drainage system that keeps the water table at or near the surface (Whinam *et al.*, 2003). Under these conditions, the decomposition of organic materials is incomplete, eventually forming the peat that typically underlies the ecological community (Good, 1992).

The nationally described ecological community listed under the EPBC Act includes two distinct components of high mountain wetlands that are both restricted in area and typically occur together – bogs and fens. Although it is not always the dominant genus, the bogs component of the ecological community can usually be defined by the visual presence of *Sphagnum* spp. (absent or less obvious in fens and degraded wetlands), the most common of which is *Sphagnum cristatum* (Kirkpatrick, 1997). The fens are shallow, open water pools with or without emergent aquatic plants and are often near to, or surrounded by bogs.

The absorptive properties of *Sphagnum* spp. and the underlying peat regulate the lateral spread of moisture within the ecological community and ultimately, this defines its boundaries. Also, some patches of the ecological community are dominated by shrubs or *Restionaceae* spp., particularly where *Sphagnum* spp. are only a minor component, or where *Sphagnum* has been depleted or lost due to past or ongoing disturbance. In these cases, the site may still be considered to be part of this ecological community if other key species are dominant (see the list of key species in Table 1 from the [Commonwealth Listing Advice on Alpine \*Sphagnum\* Bogs and Associated Fens](#)) and a peat substratum is evident.

The full description of the ecological community is in the [Commonwealth Listing Advice](#). Diagnostic keys to assist in identifying the ecological community on mainland Australia and Tasmania have been developed and included in the document '[Background information for the Alpine \*Sphagnum\* Bogs and Associated Fens National Recovery Plan](#)'.

### 2.2 Flora

#### Characteristic Flora

In the Alpine *Sphagnum* Bogs and Associated Fens of the mainland Alps, there are several characteristic flora species: *Sphagnum cristatum* forming hummocks in bogs; *Empodisma minus* in bogs and associated fens; *Carex gaudichaudiana* typically dominating fens; *Poa costiniana* occurs on the margins of bogs or invading degraded sites (Hope *et al.* 2012). The other keystone bog species are shrubs, some of which only regenerate from seed after fire and others that regenerate by resprouting (Walsh and McDougall, 2004). These shrubs have varying recovery times after fire, and this combined with hydrology, drives the dynamics of the ecological community.

Tasmanian *Sphagnum* bogs have floristic affinities with mainland bog communities at the genus and family level, including some key species such as *Empodisma minus* and *Carex gaudichaudiana*. The Tasmanian endemics *Richea gunnii* and *R. scoparia* are the major bog *epacrids* in Tasmania (Whinam *et al.*, 2001).

Further information on the characteristic flora of the ecological community can be found in the [Commonwealth Listing Advice](#) and '[Background information for the Alpine \*Sphagnum\* Bogs and Associated Fens National Recovery Plan](#)'.

### EPBC Threatened Flora found in the ecological community

There are several EPBC-listed threatened species occurring within the ecological community, some of these are also listed under the relevant State legislation. The Bogong eyebright (*Euphrasia eichleri*) is endemic to Victoria but is restricted to alpine and subalpine vegetation between the Bogong High Plains and Mt. Bogong, and possibly the Dargo High Plains.

The swamp everlasting (*Xerochrysum palustre*), listed as Vulnerable, is a widely distributed but rare herbaceous daisy that occurs in a variety of habitats including highland *Sphagnum* bogs. Its habitat extends to wet sites, mostly at lower altitude but can extend into the alpine area in a few places. It is not clear how important the ecological community is for this species.

Additionally, the Kiandra greenhood (*Pterostylis oreophila*), Bago leek orchid (*Prasophyllum bagoensis*), Brandy Mary's leek orchid (*Prasophyllum innubum*) and Kelton's leek-orchid (*Prasophyllum keltonii*) are orchid species listed as critically endangered, and are likely to occur in the ecological community. The latter three orchids are found in areas of the ecological community that occur outside of the Kosciusko National Park on Forestry leasehold land. They are seriously threatened by landuse practices (G. Hope, pers.comm. 2014).

## 2.3 Fauna

The Alpine *Sphagnum* Bogs and Associated Fens ecological community is known to provide significant habitat for a number of endemic and threatened fauna species. These include the nationally-listed critically endangered southern and northern Corroboree frogs (*Pseudophryne corroboree* and *Pseudophryne pengilleyi*, respectively) and the endangered Baw Baw frog (*Philoria frosti*) uses this environment for both breeding and hibernation. The Alpine tree frog (*Litoria verreauxii alpina*), listed as vulnerable, also uses the ecological community for breeding.

Several species of skinks are also known to use habitat in the ecological community. These include the nationally endangered Alpine she-oak skink (*Cyclodomorphus praealtus*), the Alpine water skink (*Eulamprus kosciuskoi*) and the Alpine bog skink (*Pseudomoia cryodroma*), which are listed critically endangered and endangered respectively under the Advisory List of Threatened Vertebrate fauna (VDSE, 2013) in Victoria.

The ecological community also supports the Alpine spiny crayfish (*Euastacus crassus*), listed as threatened in Victoria, and a number of species of native galaxiid fish, including the nationally endangered Barred galaxias (*Galaxias fuscus*).



*Pseudophryne corroboree* (Southern Corroboree Frog) ©Steve Wilson

## 2.4 Ecology (including hydrology)

As the name suggests, *Sphagnum* spp. are an integral component of the ecological community. While tolerant of very low nutrient (oligotrophic) conditions, *Sphagnum* maintains a very acidic pH level (3.5-4.5) that limits the range of taxa that can survive in the ecological community (Hope *et al.*, 2012). Low temperatures, permanent water, and potentially long periods of snow cover each year also influence the occurrence of the ecological community and the specialised flora and fauna it is composed of.

*Sphagnum*, along with *Empodisma minus*, contributes considerably to peat formation in bogs in the southern hemisphere, with many bogs forming on *Sphagnum* derived peat (Agnew *et al.*, 1993; Whinam *et al.*, 2003). Like peat, *Sphagnum* has a significant water holding capacity, which may be important in modulating water flow and maintaining the hydrology of surrounding vegetation (Ashton and Williams, 1989). The manner in which bog and fen communities gradually regulate water from the spring snow melt may also be important to the survival of numerous other ecological communities (Good, 1992).

The ecological community is maintained by summer groundwater rather than winter climatic regimes (Good, 1998). Although the snowpack is important for slow release of water into the bogs throughout the spring and summer thaw, snow cover itself is not a required factor in their ecology. The snow pack may assist in protecting the community during the snow-covered period from intense winds, eroding rains and solar radiation. It is these factors that have partly allowed the community to evolve into the topographic environments or macrogradients in which they now occur (Good, 1998).

The importance of bogs in the catchment hydrology of the Australian Alps has long been recognised and studies continue to investigate the importance of peat in influencing hydrological processes (Grover *et al.*, 2012). Bogs and fens rely on groundwater baseflows, which can vary depending on the position of the bog within the landscape. Bogs are sensitive to changes to groundwater flows or discharge, which may result from a range of activities (Grover and Baldock, 2010; 2012).

If the bogs and fens become damaged, their water holding capacity is frequently reduced or destroyed as a result of erosion and channelling (Ashton and Williams, 1989; Wahren *et al.*, 1996). Such degradation can lead to drying out of bogs, further reducing the integrity of the ecological community and impacting the hydrology of the surrounding area. As critical functions of the ecological community include water retention (Ashton and Williams, 1989), regulation of flows and water quality (Silvester, 2009), such changes can in turn have repercussions downstream. In particular, the ecological community plays a critical role in filtering nutrients (McDougall, 1989; Silvester, 2009) and retaining them in the ecological community.

### **Fire**

The ecological community has evolved with the occurrence of fire. Individual fires may not necessarily be considered a direct threat to the ecological community, although fire damage significantly increases its susceptibility to other threats. Repeated burning at short intervals in conjunction with high fire intensity is likely to have a detrimental impact on the ecological community (C. Pascoe, pers comm., 2014), particularly under drought conditions (Whinam *et al.*, 2010). Fire severity impacts on the peat layers and the subsequent ability of the ecological community to recover.

The impacts of fire on the ecological community are long-term (20+ years). However, evidence from recent fire suggests that whilst post-fire recovery of *Sphagnum cristatum* is frequently negligible for several years, a more rapid recovery rate can occur later (McDougall, 2007; Clarke *et al.*, in review).

### **Condition (state)**

The state of the community fluctuates over time (including hundreds to thousands of years) and little is known about its condition before European settlement. Most, if not all, of the occurrences of this ecological community on mainland Australia have been affected by various combinations of threats, such as repeated fires, expansion in range and abundance of exotic plants, and the grazing and trampling by hooved animals. Whinam and Chilcott (2002) noted historical declines in *Sphagnum* extent and suggest that UV radiation may be a factor in association with other disturbances and fire. Tasmanian bog and fen communities have also been affected by a range of threatening processes, such that degradation is also likely to be widespread, particularly on the Central Plateau.

Condition thresholds define categories of condition for an ecological community and may be used to prioritise protection for the best quality vegetation remnants by excluding very low quality examples from the legal definition. Condition thresholds have not been adopted for the ecological community. Furthermore, a method for assessing baseline condition for Alpine *Sphagnum* Bogs and Associated Fens is yet to be developed and is a recommended action in this plan (Actions 8.1b.).

### **Peat**

The presence of a peat substratum is a defining component of the ecological community. Peat is an organic soil that develops when plant material does not decompose completely because of acidic and/or anaerobic conditions. These conditions are typically promoted by permanent waterlogging. Australia's alpine and subalpine areas also have extensive peatland areas where peat accumulation is no longer active and the peat is drying. Drying peats are indicative of changes in either natural or anthropologic hydrological conditions (Costin, 1954). Such shifts can be caused by major disturbance, where processes of compaction, trenching and redirection of flow (for example from hard-hooves animals), can cause peat to dry and erode to form areas that are often termed degraded mire (Costin, 1954; Ashton and Williams, 1989).



### 3. Distribution

The Alpine *Sphagnum* Bogs and Associated Fens ecological community occurs primarily within the Australian Alps, the Tasmanian Central Highlands and the Tasmanian Southern Ranges Interim Biogeographic Regionalisation for Australia (IBRA) bioregions. It is also found in a small area of the Bondo subregion of the South Eastern Highlands IBRA bioregion on mainland Australia, and may be present within the Ben Lomond and Tasmanian South East IBRA bioregions in Tasmania. The ecological community occurs in small pockets in New South Wales and the Australian Capital Territory (see Map 1 below), Victoria (see Map 2 below) and Tasmania (see Map 3 below). The ecological community consists mostly of scattered, isolated patches, and its geographic extent is restricted. Most examples of the ecological community are situated within national parks and other conservation-related land tenure.

The ecological community is typically found in alpine, sub-alpine and montane (mountainous, or of higher elevation) environments, on gentle to moderate slopes amongst trees, in frost-prone valleys and plains, and sometimes above the climatic treeline.

From a geographical perspective, alpine and subalpine regions generally occur above 1,400 metres above sea level (ASL) on the mainland and above 800 metres ASL in Tasmania (Kirkpatrick, 1997; Slattery, 1998). However, the ecological community may occur in isolated pockets as low as 800 to 1,000 metres ASL in parts of the mainland, and 650 metres ASL in Tasmania.

#### 3.1 Important occurrences

It is difficult to identify particular habitats critical to the survival of the ecological community. The ecological community is dependent on the maintenance of local hydrological conditions, particularly ground water. The limited distribution and scattered nature of the ecological community, together with the importance of each occurrence to the catchment they occur within, mean that all occurrences are of high conservation value and therefore considered important. In addition, the overall health of local catchments is important to the survival of the ecological community.

Factors important to the survival of the ecological community include:

- the area of occupancy of known occurrences
- habitat adjacent to known occurrences (within approximately 200 m), including vegetation communities or peatlands with similar structure/hydrology and/or species composition
- remnant native vegetation that surrounds or links several occurrences (that provide habitat for pollinators or allow them to move between occurrences).

#### 3.2 Areas of the ecological community under particular pressure for survival

The likelihood of persistence of the ecological community can be impacted by one or more of the following factors:

- fire impacts
- grazing and trampling from domestic stock
- wallowing, grazing and trampling from feral horses, pigs and deer
- localised impacts from weed infestation,
- localised impacts from infrastructure and associated activities, and from timber harvesting.

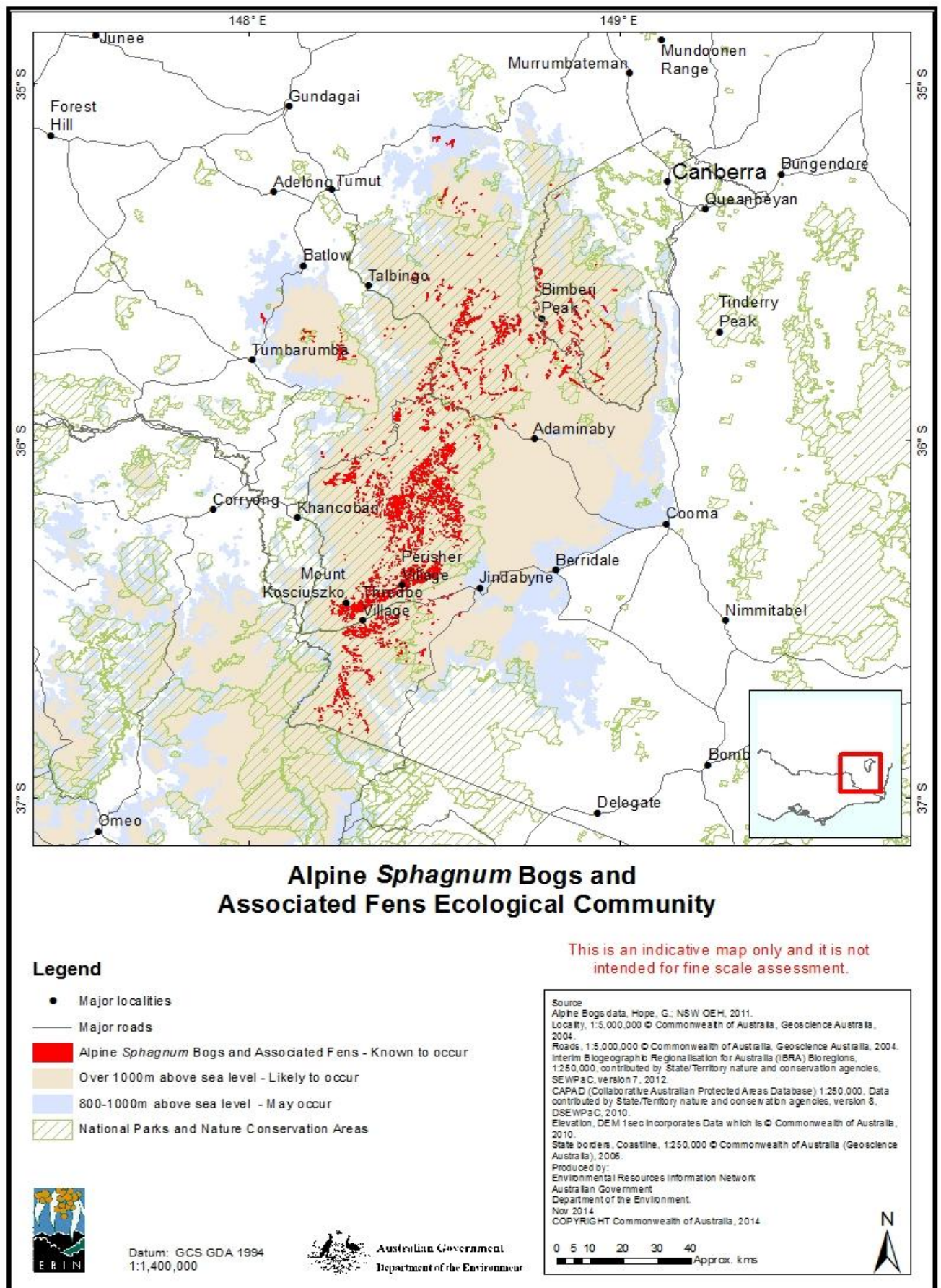
These threats are discussed further in *Section 4 - Threats*.

Priority sites for protection in New South Wales and the Australian Capital Territory are listed in a Technical report prepared for the NSW Office of Environment and Heritage (Hope *et al.*, 2012). In Victoria, priority sites and actions are identified in the Victorian Alpine Peatlands Spatial Action Plan (VEPI in prep.). Priority sites in Tasmania include those within the Central Plateau.

Indicative distribution maps of the ecological community across each state and territory are on pages 13-15 (Maps 1, 2 and 3).

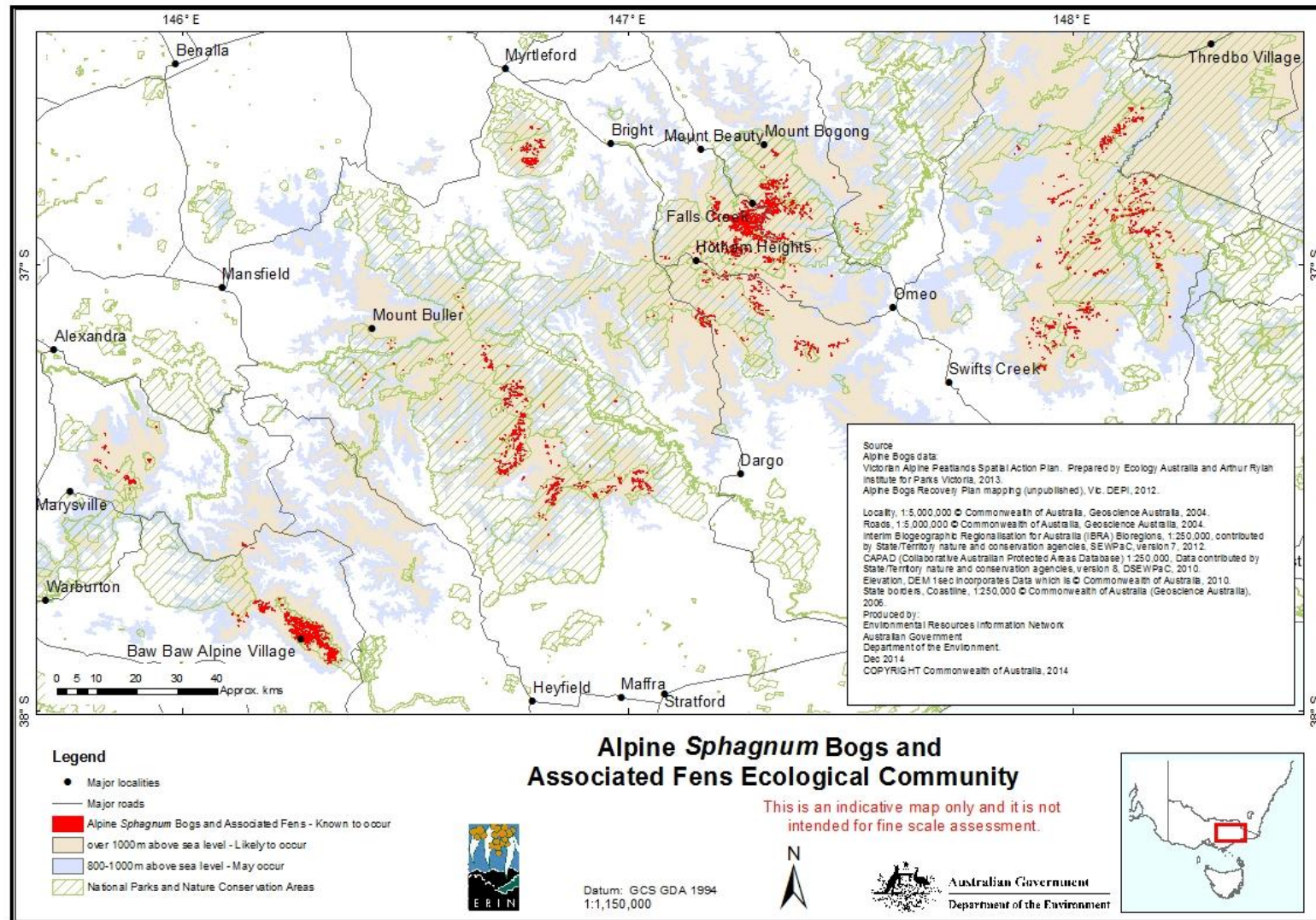


Map 1: Indicative distribution of the ecological community in ACT and NSW

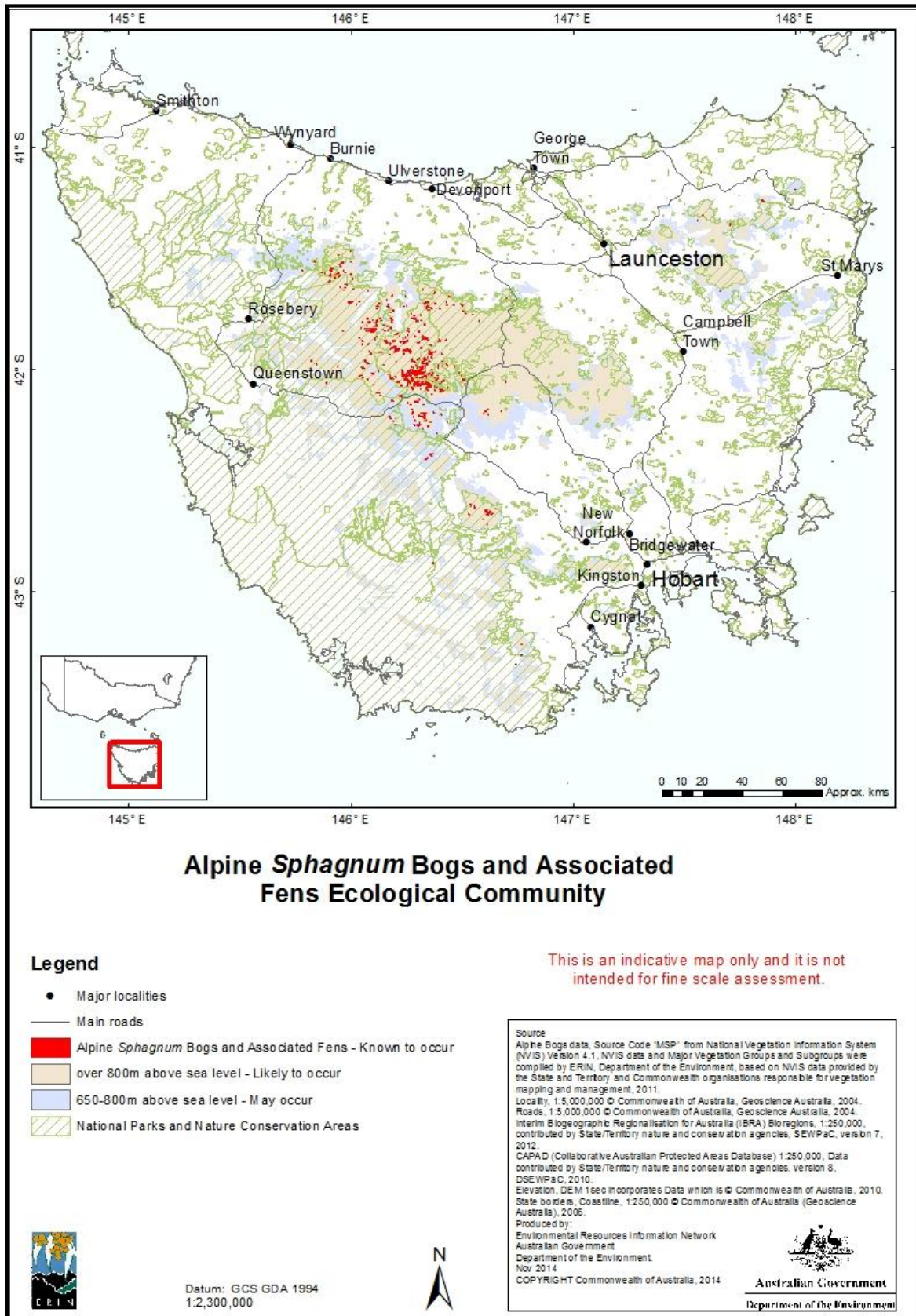




Map 2: Indicative distribution of the ecological community in Victoria



**Map 3: Indicative distribution of the ecological community in Tasmania**





## 4. Threats

Alpine vegetation is particularly vulnerable to disturbances, due in part to the restricted growing season of the alpine and subalpine regions, but also the very fragile nature of some systems, particularly alpine snowpatch vegetation and the Alpine *Sphagnum* Bogs and Associated Fens ecological community (Ashton and Williams, 1989).

The effects of a range of threats impacting on the integrity of the ecological community are complex, long lasting and may have serious implications for persistence of the ecological community in some locations. Where damage has occurred, the recovery of structure and function is likely to take several decades (McDougall, 2007). Furthermore, if *Sphagnum* has been completely lost from a site, both the *Sphagnum* and the bogs that depend on it for the development of permanently moist conditions, may become locally extinct unless new *Sphagnum* plants can be introduced (Walsh and McDougall, 2004).

The impacts of threats acting on the ecological community may be exacerbated by the interaction of more than one threat: for example, bushfires, particularly frequent bushfires render the ecological community more susceptible to weed invasion.

The jurisdictions involved in the development of this plan, already manage and/or have historically managed these threats to some degree, including through whole of Alps efforts with the Australian government. Continued coordination and cooperation under the guidance of this national recovery plan will be beneficial to the long-term mitigation of threats.

### 4.1 National severity rating

A risk assessment, estimating the likelihood of a threat occurring and the consequence of its occurrence, was undertaken for each of the key identified threats at the jurisdictional level. The risk assessment was undertaken for both known (existing) threats and potential threats that are new or emerging. Dealing with the emergence of a new threat or new incursion of an existing threat quickly, before it establishes, should be considered a high priority and will be more cost effective.

The risk assessment ratings were consolidated to provide an overall national level severity rating (Table 1). It is acknowledged that state by state, the severity ratings against the threats below may vary slightly. This is reflected in the prioritisation of the actions and tasks in Table 2, where state by state prioritisations of tasks may vary.

**Table 1:** National Severity rating of key threats

Category	Threat (source)	National Severity Rating
Climate change	Climate change	Very High
Fire	Fire frequency and intensity	Very High
Domestic stock	Grazing and trampling	Very High
Invasive species	Feral horses	Very High
	Deer	High
	Feral pigs	High
	Rabbits and hares	Low
	Foxes (impacts on fauna)	Medium
	Cats (impacts on fauna)	Medium
	Trout (impacts on fauna)	High

Invasive species	Weeds – woody	Very High
	Weeds – non-woody	Very high
	Pathogens/disease (including <i>chytrid</i> , <i>Phytophthora</i> , and potentially myrtle rust and Didymo)	Very High
Infrastructure, development and recreation	Water infrastructure (includes aqueducts, hydro developments)	Very High
	Resort development	High
	Tracks and Roads	Medium
	Off-track recreation use	Medium
Resource use	Peat and Sphagnum harvesting	Very High
	Timber harvesting	Medium
	Ground-water extraction	Medium

## 4.2 Climate change

Climate change must be considered as the most insidious threat impacting the Alpine *Sphagnum* Bogs and Associated Fens ecological community, even though the future implications and specific details are as yet unclear (Keith, 2004; McDougall and Walsh, 2007; Williams and McDougall, 2007). Climate change has the potential to magnify current threats, including fire and invasive species. Global trends in weed species suggest that weed species richness is increasing at higher elevations including in the Australian Alps (Johnston and Pickering 2001; Mallen-Cooper and Pickering 2008). The Australian Alps has been identified as a hot spot for future potential invasions from species already naturalised in disturbed habitats or lowland areas (Duursma *et al.*, 2013).

It is projected that the parts of ecological communities occurring at the climatic and elevational limits of their possible range are amongst the most vulnerable to the potential impacts of a changing climate (Mansergh *et al.*, 2002; Whinam *et al.*, 2003). The ecological community is a specific example of this situation. Even a small increase in mean ambient temperature is likely to result in the loss of more bogs and fens due to changes in snowfall and snowmelt regimes, which in turn affect groundwater and runoff patterns. Although there is little documented evidence of ecological responses to warming as yet (Wahren *et al.*, 2013; Clarke *et al.*, 2014), observed trends show a significant decline in snow cover and snow depth since the 1960's in the south-east Australian highlands (Dunlop and Brown, 2008; Osborne, Green and Davis, 1998). Models of climate change impacts on natural snow cover also suggest continuing reduction of the snow pack even under modest climate change scenarios (Galloway, 1988; Hewitt, 1994; Whetton, 1998; CIG, 1996). Over time, a reduction in snowmelt and soil moisture is likely to result in occurrences of the ecological community being replaced by tussock grasslands or wet heath assemblages (Pickering *et al.* 2004).

In addition, recent literature supports the proposition that mountain regions will become critical refugia for both flora and fauna under enhanced greenhouse scenarios (Shoo and Williams, 2006; Mackey *et al.*, 2012), which will affect alpine bogs and fens found in those areas (Mansergh *et al.*, 2002).

### 4.3 Fire

The post-European settlement practice of burning to provide green feed for livestock and supposedly to reduce fuel load has permanently altered parts of the Australian alpine and subalpine landscape. Most of the detrimental changes to this ecological community that can follow a fire, such as loss of vegetation cover and subsequent soil loss, are also associated with the impacts of grazing and exotic weed invasion, both of which are addressed elsewhere in this section.

Although the ecological community has evolved with fire, fire is not a process that supports the ecosystem function of the Alpine *Sphagnum* Bogs and Associated Fens (e.g. the vegetation does not require fire for germination processes). Therefore, a fire regime with long intervals between disturbances is unlikely to result in the long-term decline in the condition of the ecological community. The greatest threat from fire is where there are repeated disturbances without adequate time for recovery in vegetation cover and diversity (McDougall, 2007; Whinam *et al.*, 2010). A high intensity fire is also more likely to reduce vegetation cover and damage underlying peat layers. A reduction in vegetation cover within and adjoining alpine bogs and fens may result in changes in hydrological regimes and increase the risk of invasion by exotic species. Equally, threats that impact on hydrology can exacerbate the impacts from fire.

Over 1.4 million hectares of alpine and subalpine country in north-east Victoria, south-east NSW and the ACT were severely burnt by the bushfires of January 2003. Large areas covered by the ecological community were affected (Gill *et al.*, 2004; Hope *et al.*, 2005). The impacts of the 2003 bushfires were variable, depending on the particular location, vegetation type, fire intensity and prevailing weather conditions that occurred at the time. The result was a mosaic of variously-sized areas (square metres to hundreds of hectares) of severely burnt and unburnt vegetation (Crabb, 2003).

The potential for increased frequency of high intensity fires developing each year as climate change evolves is significant, and is already resulting in landscape-wide vegetation and soil change in alpine areas. This suggests that even one highly intense fire in the future may have catastrophic outcomes for the structure, diversity and loss of vegetation in the ecological community over large areas.

### 4.4 Domestic stock

One of the well documented threats to alpine vegetation is the impact of animals introduced to Australia since European settlement. All alpine and subalpine regions on the mainland and in Tasmania were used for summer grazing of domestic cattle from the early 1800s. Grazing in national parks in Tasmania, NSW and the ACT ceased by the 1970s and 1980s (considerably earlier in some areas, such as 1914 in the Cotter Catchment, ACT) and formally came to an end in Victoria in 2005 (Kirkpatrick, 1983; Ashton and Williams, 1989; Crabb, 2003; Jacobs, 2005), with exception of grazing trials for fuel load reduction in the Wonnangatta Valley. Where cattle have restricted access to the national parks, it is critical that key management options such as fencing, conditional licenses and enforcement are strengthened, as grazing continues in neighbouring state forests and on private lands and there is potential for cattle to stray from these areas into sensitive areas.

Australian soils and vegetation are very susceptible to the impacts of hooved animals. In particular, *Sphagnum* is easily crushed and broken up by trampling and wallowing, both of which are inevitable around any water course where animals are liable to congregate on a regular basis. Cattle and horse hoof prints are especially enduring in *Sphagnum cristatum* at the edges of pools and streams (McDougall, 2007). Once the *Sphagnum* cover is lost, alpine soils and peat environments are very susceptible to desiccation, incision and soil erosion (Good, 1992). Trampling and wallowing cause channels to form in the disturbed *Sphagnum* and underlying peat, resulting in water exiting the landscape more rapidly than occurs in undisturbed bogs. The formation of channels is in turn detrimental to the fens associated with the bogs. Where *Sphagnum* cover has been impacted by non-native animals, these channels can result in the fens draining directly into the stream system.



Photo showing pugging damage from stock in bogs on the Nunniong Plateau, Victoria. Photo by Arn Tolsma.



Photo showing legacy of historic grazing damage (stream incision) in Alpine Sphagnum Bogs and Associated Fens at Betts Creek, Kosciuszko National Park. ©Kåren Watson.

## 4.5 Invasive Species - Fauna

### Feral horses

In alpine, subalpine and montane areas of the Australian mainland, along with domestic stock, feral horses are the largest animals to impact on the ecological community and represent a threat that requires complex management strategies (O'Brien and Wren, 2002).

Feral horse populations in NSW and Victoria have been increasing at a rate that has outpaced active management. The number of feral horses in the Australian Alps national parks increased by approximately 20 per cent annually between 2003 and 2009 from an estimated 2,500 to 7,600 (Dawson, 2009). Worboys and Pulsford (2013) observed the direct impacts of a 'very large number of horses' and considered the damage to be comparable to the worst historic domestic grazing pressures that triggered the removal of stock from Kosciuszko National Park in the 1940s. Preliminary numbers from the latest aerial count of feral horses in April and May 2014 found that



horse numbers increased in Kosciuszko National Park to 6,000 horses, an almost 50% increase since the last count in 2009 of 4,200 horse (AALC, in prep).

Feral horses are not currently present as a threat in Tasmania, nor considered an active threat in the ACT.

#### **Feral deer**

Feral deer (including sambar, rusa and fallow deer) are also threatening biodiversity in the Alpine and subalpine areas of mainland Australia and Tasmania. Deer populations (and extent) have increased significantly in recent years. They are rated as a 'high threat' and it is largely an unabated problem in eastern Australia. There is limited information available on their potential proliferation, but they can cause significant damage to the ecological community through trampling, browsing and wallowing. During the latest feral horse aerial count in Kosciuszko National Park, an estimate of around 1,000 feral deer was observed (AALC, in prep).

#### **Feral Pigs**

Feral pigs are a significant problem causing damage to bogs in both the ACT and NSW, but are less problematic in Victoria and are not currently present in mainland Tasmania. Damage generally occurs on the edges of, or grasslands adjacent to, bogs where these animals wallow in pools and waterways. They dig and uproot vegetation over large areas, making pigs an ongoing threat to the structural integrity of the ecological community.

#### **Rabbits**

Rabbits can reduce cover and diversity of forb species in sub-alpine areas and disturb the soil by digging (Leigh *et al.*, 1987). Greater numbers of rabbits are often prevalent post-fire, which inhibits vegetation resprouting and regeneration (Leigh *et al.*, 1987). Although there is some evidence that rabbits can be active at the margins of some bogs, it appears to be relatively minor (Tolsma and Shannon, 2009).

#### **Foxes, cats and trout**

In some high altitude areas, including in the ecological community, foxes and cats may impact: populations of native frogs (including the critically endangered corroboree frogs - *Pseudophryne* spp. and the endangered Alpine tree frog - *Litoria verreauxii alpina*); native fish (*Galaxias* spp.); native reptiles (including the threatened Alpine she-oak and Alpine water skinks); and, Alpine spiny crays (*Eustacus* and *Engaeus* spp.). Trout generally remain small (less than 20 centimetres) in smaller streams and fens, such as for this ecological community. However, an incursion could have a major impact on native *Galaxias* species, including the potential extinction of species known from only one or a few locations.

## **4.6 Invasive species - Flora**

### **Weeds**

Exotic weed invasion is a current and increasing threat to the ecological community, and due to the sensitivity of wetlands to some chemicals, effective control of weeds (particularly non-woody weeds needing chemical control) in the ecological community is challenging. There are several known invasive plant species that have serious impacts on bog flora composition. Most of these species have the capacity to progressively invade an undisturbed occurrence of the ecological community and the rate of invasion is greatly exacerbated by intensive disturbance, such as by bushfire, feral horses and pigs. The interaction between large fires and weeds has been identified as a key threat to the resilience and function of alpine ecosystems (Williams *et al.*, 2008). Post-fire studies in the Kosciuszko National park have found a significant increase in both diversity and average numbers of weeds impacting on bog sites (Hope *et al.*, 2005).

Although there are currently almost no weeds in the ecological community at higher altitudes, there are areas of the ecological community in subalpine areas with localised and specific weed occurrences. That these weeds occur in the ecological community at all indicates they are likely to become a serious threat in the future (K. McDougall pers. comm., 2014). Weed invasion has the potential to reduce or destroy the composition of the ecological community. Some exotic weeds, such as *Juncus* spp. and willows (*Salix* spp.), have the capacity to establish in such abundance that they permanently alter floristic composition and structural integrity, as well as affecting the overall hydrology of the area (McDougall, 2007).

#### **Weeds - woody**

Willow (*Salix* spp. – particularly *Salix cinerea*) invasion into the ecological community can cause major structural impacts and fundamental alteration of root structures and hydrology, as has occurred in many other river and freshwater systems (Cremer, 1995; 1999). Willows are a significant issue, particularly in Victoria, where willow spread and infestation has increased in recent years due mainly to repeated major fire events.

#### **Weeds - Non-woody**

A number of herbaceous weeds currently threaten the Alpine *Sphagnum* Bogs and Associated Fens ecological community and in some cases have become widely established. For example, *Juncus effusus* is now in such abundance in some previously grazed areas (e.g. Rocky Valley on the Bogong High Plains) that it is permanently altering the floristic composition and vegetative structure of some bog and fen sites (Walsh and McDougall, 2004; McDougall, 2007).

The ecological community in both Tasmania and the ACT has remained without weed issues, although *Eragrostis curvula* (African love-grass) has been recently discovered in several high altitude bogs (G. Hope pers. comm., 2014) in the ACT. This invasive grass species is widespread throughout urban areas of the ACT and in surrounding rural districts.

Other herbaceous weed species commonly found in the ecological community include *Lotus uliginosus* (birds-foot trefoil), *Mimulus moschatus* (musk monkey flower), *Agrostis capillaris* (creeping bent grass), *Phleum pratense* (timothy grass) *Anthoxanthum odoratum* (sweet vernal-grass), *Holcus lanatus* (Yorkshire fog), and *Hypochaeris radicata* (cat's ear) (McDougall and Walsh, 2007; VDSE, 2007). *Glyceria maxima* (reed sweet grass), *Phalaris arundinacea* (reed canary grass), *Juncus articulatus* (jointed rush), *Leucanthemum vulgare* (ox-eye daisy), and *Myosotis laxa* subsp. *caespitosa* (water forget-me-not) are currently localised within the extent of the ecological community but may pose a significant threat in the future based on their impact elsewhere (K. McDougall pers. comm., 2014; J. Shannon pers. comm., 2014). Other common incidental weeds include *Acetosella vulgaris* (sheep sorrel) and *Poa annua* (annual meadow grass) (G. Hope pers. comm., 2014).

## **4.7 Pathogens and Diseases**

Similar to the threat of fire, pathogens are unpredictable in terms of where and when they will appear. Containment or control of a pathogenic infestation in isolation is always likely to be difficult, but is recommended given the consequences of a pathogenic outbreak in combination with other threats facing the ecological community could be very high.

*Chytrid* fungus is a known pathogen causing the disease *Chytridiomycosis* in frogs and has been listed under the EPBC Act as a Key Threatening Process contributing to the decline in Australian frog species. Although there is no documented suggestion that *Chytrid* is of significant threat to the ecological community, it unquestionably affects the health of its frog fauna. These include the northern and southern corroboree frogs, the Alpine tree frog and Baw Baw frog, all of which are part of the ecological community fauna and have recorded major declines in population due in large part

to this fungal disease. The Australian Government has produced a [Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis](#).

Other pathogens likely to emerge or become introduced to alpine, sub alpine and montane areas include *Phytophthora*, myrtle rust and didymo. Dieback of vegetation caused by *Phytophthora cambivora* has recently been detected in the alpine area of Kosciuszko National Park (Green and McDougall, pers. comms., 2014). The emergence of *Phytophthora* and potentially other diseases and pathogens in areas where they have been previously absent may be linked to a changing climate. The Australian Government has produced a [Threat abatement plan for disease in natural ecosystems caused by \*Phytophthora cinnamomi\*](#). Although not currently occurring in Australia, Didymo is a highly invasive alga (diatom) of waterways and is an increasingly significant problem in New Zealand.

## 4.8 Infrastructure, development and recreation

Tourism, associated infrastructure and other human uses of the area encompass a range of localised threats affecting the Alpine *Sphagnum* Bogs and Associated Fens ecological community, even within national parks. Recreational demands on alpine and subalpine regions continue to rise as more people visit the area in the summer months, as well as the more traditional winter ski season (McDougall and Walsh, 2007). Trampling of vegetation by walkers not keeping to pathways is a problem (Whinam and Chilcott, 2002). The expansion of trail networks created largely to accommodate the popularity of mountain bikes and horse riding is a potential threat if created near the ecological community. These activities have the potential to impact the ecological community indirectly where damage such as erosion, increased sediments and runoff diversions alter hydrology.

Other threats include: ski resort developments, particularly the modification of ski slopes through vegetation and rock removal, which alters hydrology; and associated roadworks and dams required for the production of hydro-electricity (McDougall and Walsh, 2007). Dams and aqueducts are a significant issue due to their permanent impact on local hydrology, as they can lead to affected bogs and fens being drained and ultimately drying out.

## 4.9 Resource use

*Sphagnum* moss has previously been harvested from the wild for use in the horticultural industry, notably in Tasmania, with very minor amounts coming from Victoria and NSW (Whinam and Buxton, 1997). The Australian Code of Practice for *Sphagnum* harvesting states that harvesting should not be carried out in alpine or subalpine environments. However, illegal harvest does occur (TDPIW, 2007). Forestry Tasmania ceased issuing permits to harvest *Sphagnum* moss from the forest estate in 2011.

Timber harvesting and silvicultural regimes in catchments containing Alpine *Sphagnum* Bogs and Associated Fens may impact the community through physical disturbance and the potential for associated changes in local hydrology, as well as through fire regimes (Whinam and Chilcott, 2000).

Ground water extraction proposals are a newly-emerging issue that may be a potential high-impact threat to the long-term hydrological health of the ecological community. Groundwater extraction may be a localised threat to the ecological community, depending on the amount of water extracted and the locality.

## 5. Recovery Programme

### 5.1 Objectives

As indicated in the Introduction to this recovery plan, the objectives are:

**Primary objective:**

Maintain or extend the current known extent (area) and maintain or improve the condition of the Alpine *Sphagnum* Bogs and Associated Fens ecological community over the life of the recovery plan.

**Supporting objective:**

Ensure effective and adaptive implementation of the plan.

### 5.2 Strategies

The objectives of the recovery plan will be achieved by three strategies:

- Implementing the priority recovery actions identified in the recovery plan to address the threats most influencing the ongoing survival of the ecological community;
- Maintaining or improving the condition of the ecological community through supporting research and restoration efforts to enhance the resilience of the ecological community to adapt to climate change; and
- Improving knowledge of the ecological community, monitoring its status, and using adaptive management in response to new information.

The following factors will be important for the successful delivery of the strategies:

- Sufficient and enduring funding to complete priority actions;
- Recognition and appreciation of the significant ecosystem services provided by the ecological community;
- Recognition that maintenance and recovery of this ecological community requires commitment to on-ground actions and long-term effort;
- A community that values the alpine and subalpine environments and their role in biodiversity conservation and ecosystem services;
- A culture of inclusiveness, transparency and accountability for all aspects of the recovery program by recovery program partners;
- Effective mechanisms for cross jurisdictional co-operation and coordination to implement priority actions efficiently and effectively;
- The integration of Alpine bog management with other threatened species recovery actions (e.g. corroboree frog);
- A network of stakeholders and partners that includes relevant experts, delivery partners and affected interests;
- Effective mechanisms for communicating with stakeholders and partners;
- A strong adaptive management framework for program delivery, with the capacity for adaptive and timely decision-making based on monitoring data.

This ecological community will continue to be impacted by climate change. It is outside of the scope of this plan to address the drivers of climate change. Implementing the actions identified in this plan will support the resilience of the Alpine *Sphagnum* Bogs and Associated Fens and its ability to adapt to a changing climate.

The objectives, strategies and actions are consistent with the priority management for landscape-scale responses recommended by the Caring for our Australian Alps Catchments report (Worboys *et al.*, 2011).

### 5.3 Performance criteria

The plan requires a short review in 5 years and a full review after 10 years. It is intended that any reviews will measure the success of the recovery plan in achieving the overall objective and supporting objective using the following performance criteria.

Overall objective and performance criteria:

**Maintain or extend the current known extent (area) and maintain or improve condition of the Alpine *Sphagnum* Bogs and Associated Fens ecological community over the life of the recovery plan.**

Achievement of this objective will be measured against the following performance criterion:

There has been no known decrease in extent or overall condition of the ecological community between 2015, 2020 and 2025 (to be further informed by condition baselines as they become available).

Supporting objective and performance criteria:

**Ensure effective adaptive implementation of the plan**

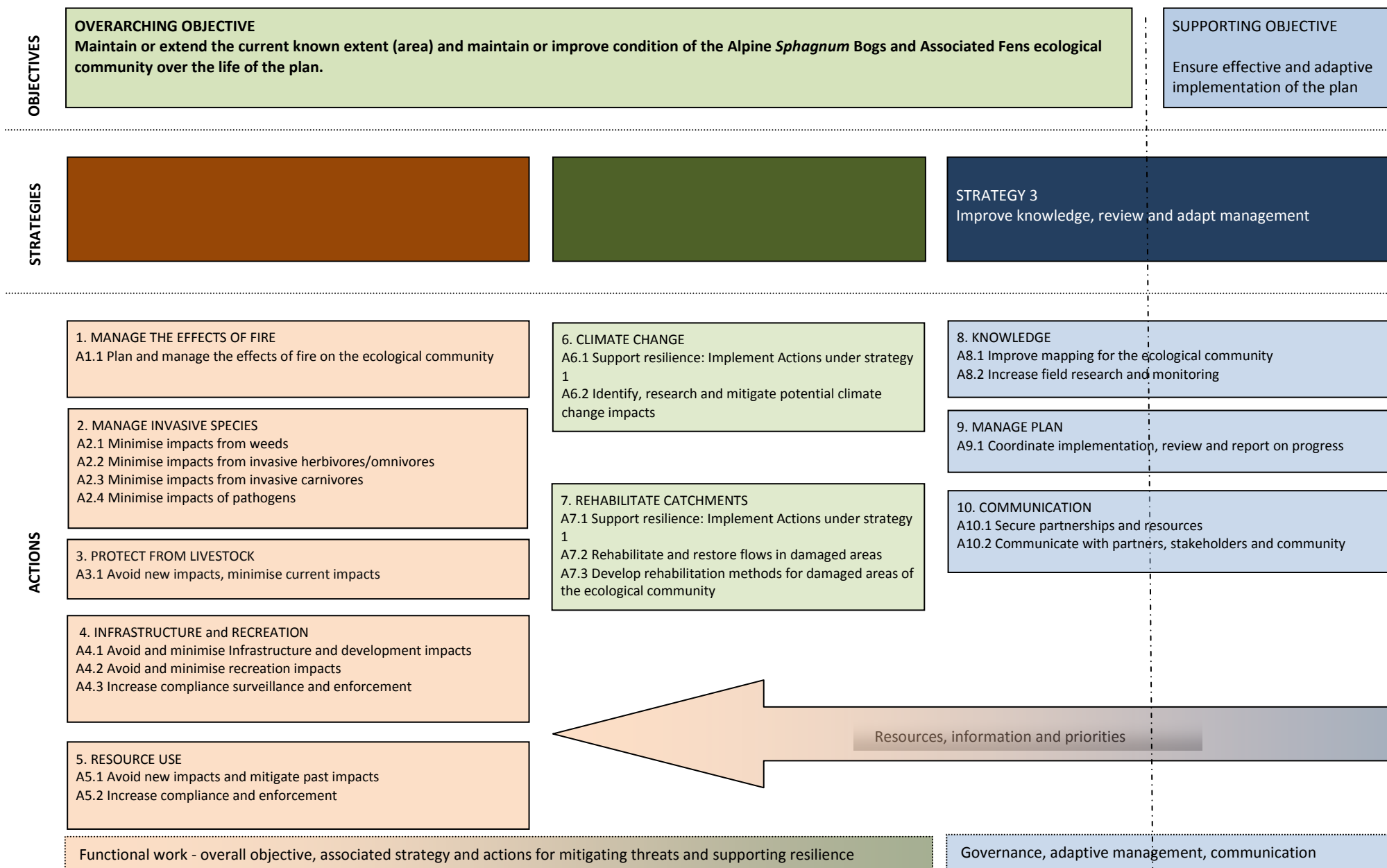
Achievement of this objective will be measured against the following performance criterion:

Priority actions have been undertaken, the results understood and shared, and any required modifications to priority actions made as new information became available.

The strategies, actions and the specific tasks to be undertaken are outlined below.

## Relationship between objectives, strategies and recovery actions

Actions and strategies are summarised. Please refer to the Recovery Actions section below for details.



## 5.4 Recovery Actions

The Recovery Actions table below (**Table 2**) outlines the actions and associated tasks or activities to be undertaken to implement each of the three strategies and achieve the objectives. The priority recovery actions are informed by current knowledge, threats and regulatory arrangements.

The priority ratings allocated to actions and tasks in **Table 2** have been guided by input from state/territory authorities and other experts taking into account the risk that a threat poses to the ecological community (through assessing the likelihood the impacts of the threat will occur, the severity of the impacts as per **Table 1** and the extent of the impacts) and the likelihood of success in undertaking actions to address the threat.

The actions and tasks have been prioritised separately into 'Australian Alps' (ACT, NSW and Victoria) and Tasmania in recognition of geographic separation, some key differences in the biotic and abiotic elements, and that Alpine *Sphagnum* Bogs and Associated Fens in these two areas have some different threats and management challenges (for example, resources and seasonal timing). Differences in priority between the two main areas do not necessarily indicate that a threat has a different level of impact (or potential impact). Different local conditions, threats and impacts should also be considered for each catchment and occurrence of the ecological community. For example, actions and tasks might be given a lower priority for one of the two main areas because 1) they are already being implemented, 2) they are already considered within existing legislative or planning measures, or 3) the threat may be locally severe but insubstantial across the full range of the community. For this reason, the priorities should be compared within the two main areas but not between them.

The attainment of objectives and the provision of funds necessary to implement actions are subject to budgetary and other constraints. It is recommended that tasks prioritised as moderate to highest are implemented at a minimum.

Consistent with an adaptive management approach, it is intended that the actions, tasks and priority ratings are refined where new information becomes available and/or circumstances change.



Table 2: Priority recovery actions and tasks

Strategy 1. MANAGE AND REDUCE THREATS TO THE ECOLOGICAL COMMUNITY			
Action 1 - MANAGE THE EFFECTS OF FIRE	Tasks to minimise the threat and impacts of fire on the ecological community	Priority rating	
		ACT /NSW/VIC	TAS
<b>1.1 Plan and manage the effects of fire on the ecological community.</b>	a. Maintain accurate fire history via mapping of extent, frequency, severity (or intensity) and regeneration (see also Action 8.1).	Moderate-high	Highest
	b. Incorporate appropriate management guidelines for fire suppression in the ecological community as part of fire management plans.	High	Highest
	c. Improve knowledge about the importance and locations of the ecological community for field staff and fire management operators.	High	Highest
	d. Avoid negative impacts to the ecological community from fuel reduction burns.	High	Highest
	e. Avoid damage to the ecological community from activities associated with fire management operations (e.g. control line construction vehicle access, back burning).	Highest	Highest
	f. Develop an ecological procedure for assessing fire impacts and required responses (e.g. additional protection) to mitigate fire impacts and monitor regeneration over time.	High	Highest
	g. Develop and implement targeted management responses for fire affected areas (for example through restricting access in the post fire recovery period).	Highest	Highest

Action 2 - MANAGE INVASIVE SPECIES	Tasks to eliminate impacts of invasive species and diseases where they occur and prevent them from establishing at sites where they do not occur.		Priority rating	
			ACT/NSW/VIC	TAS
<b>2.1 Minimise the impacts of weeds (woody and non-woody) on the ecological community, (consistent with national and regional weed management plans, where applicable).</b>	a. Prevent the establishment of weeds likely to threaten the ecological community.	Woody	Highest	Highest
		Non-woody	Highest	Highest
	b. Eradicate, contain or control existing weeds threatening the ecological community; such as willow ( <i>Salix</i> spp.), and <i>Juncus effusus</i> .	Woody	Highest	Highest
		Non-woody	Highest	Moderate
	c. Encourage private landholders, ski resorts and other land managers to prevent, eradicate, contain or control weeds that are threatening or could threaten the ecological community.	Woody	High	Highest
		Non-woody	Moderate-high	Moderate
	d. Undertake surveillance, monitoring and mapping of weeds threatening the ecological community, including new outbreaks and emerging threats.	Woody	Moderate-high	Moderate
		Non-woody	High	Moderate
	e. Identify sources of weed introduction and infestation, to prioritise targeted monitoring and control.	Woody	Moderate	Moderate
		Non-woody	Moderate	Moderate
	f. Identify priority weed species and prepare and disseminate information to help engage land managers and the public in identifying and reporting new incursions.	Woody	Moderate	Low-moderate
		Non-woody	Moderate	Moderate
	g. Investigate control techniques for identified priority weed species, where control methods are not well understood.	Woody	Moderate	Low
		Non-woody	Moderate	Low-moderate

Action 2 - MANAGE INVASIVE SPECIES	Tasks to eliminate impacts of invasive species and diseases where they occur and prevent them from establishing at sites where they do not occur.	Priority rating	
		ACT/NSW/VIC	TAS
<b>2.2 Minimise the impact of invasive herbivores/omnivores on the ecological community, (consistent with national and regional invasive animal plans, where applicable).</b>	a. Prevent establishment of new populations of hoofed animals, particularly feral horses, feral pigs and deer.	Highest (horses) Moderate-high (pigs, deer)	Highest (horses, pigs) Moderate-high (deer)
	b. Manage, contain or control existing populations of feral horses, feral pigs, deer, rabbits and hares.	Highest (pigs, horses and deer) Low-moderate (rabbits and hares)	Highest (rabbits) Low-mod (deer) (horses and pigs not present)
	c. Encourage private landholders, ski resorts and other land managers to prevent, eradicate, contain or control invasive herbivores threatening the ecological community.	Moderate-high	Moderate-high
	d. Undertake surveillance, monitoring and mapping of invasive fauna threatening the ecological community, including new incursions and emerging threats (see also Task 8.1a).	Moderate	Moderate
<b>2.3 Minimise impact of invasive carnivores on the ecological community's fauna (consistent with national and regional invasive animal plans).</b>	a. Eradicate, contain or control existing populations of foxes and cats threatening fauna in the ecological community.	Low-moderate	Low
	b. Prevent establishment of new populations of trout in high altitude streams and water bodies where they currently don't occur and eradicate, contain or control trout in fens where galaxiid populations are known or could be re-established.	High	Highest

Action 2 - MANAGE INVASIVE SPECIES	Tasks to eliminate impacts of invasive species and diseases where they occur and prevent them from establishing at sites where they do not occur.	Priority rating	
		ACT/NSW/VIC	TAS
<b>2.4 Minimise the impacts of pathogens/diseases on the ecological community, (consistent with national and regional disease management plans).</b>	a. Continue vigilance for new disease outbreaks and emerging threats by developing field capability in land management staff, public and private landholders in identifying diseases likely to threaten the ecological community.	Moderate	Moderate
	b. Where possible, identify, prevent, eradicate, contain or control pathogens and diseases where they threaten the ecological community.	Moderate	Moderate
Action 3 - PROTECT FROM LIVESTOCK IMPACTS	Tasks to avoid new impacts on the ecological community where livestock impacts don't currently occur and minimise impacts where they do occur	Priority rating	
		ACT/NSW/VIC	TAS
<b>3.1 Avoid and minimise the impacts from livestock on the ecological community.</b>	a. For National Parks, State Forests and other public land, prevent livestock impacts from occurring to the ecological community where these impacts are currently absent.	Highest	Moderate
	b. Minimise the impacts from livestock where livestock may occur in or adjacent to the ecological community (i.e. fence, buffer, prevent weed introduction and rehabilitate).	High	Highest
	c. Work with landholders to minimise or remove the impact of livestock on the ecological community, including through promoting the exclusion of livestock from bogs.	Moderate-high	Highest

Action 4 - INFRASTRUCTURE and RECREATION	Tasks to avoid new impacts from infrastructure and recreational activities and minimise impacts where they do occur.	Priority rating	
		ACT/NSW/VIC	TAS
<b>4.1 Avoid and minimise impacts of infrastructure and development.</b>	a. Identify areas of the ecological community in proximity to and potentially impacted by roads and tracks, hydroelectric operations, ski resorts and other infrastructure.	Moderate	Moderate
	b. Develop site-specific management actions to reduce impacts on the ecological community from existing infrastructure and maintenance activities where possible.	Moderate	Moderate
	c. Identify opportunities where infrastructure including roads, tracks, aqueducts that are no longer required may be removed or altered to restore the ecological community.	Low-moderate	Moderate
	d. Ensure that new infrastructure, including roads, tracks, trails and ski resort infrastructure, is planned to avoid impacts on the ecological community.	Highest	Highest
	e. Develop and distribute maps and specific guidelines for use in development applications (e.g. Local Councils; see also Action 8.1).	Low-moderate	Moderate
<b>4.2 Avoid and minimise impacts of recreational activities.</b>	a. Ensure that permitted off-track recreational activities do not impact the ecological community.	Moderate	Moderate
	b. Mitigate the impacts of illegal or inappropriate off-track use by managing sites to prevent access and rehabilitating damaged sites.	Moderate	Moderate

	c. Promote awareness about the ecological community and its vulnerability to damage by recreational activities to user groups through various media and interpretation methods.	Low-moderate	Moderate
	d. Support research to understand the potential impacts of changing recreational use patterns (e.g. increased summer visitation, mountain bikes, horse riding) on the ecological community.	Low	Low
	e. Support research to understand the impacts of reducing snow depths and associated recreation use on the ecological community.	Low	Low
<b>4.3 Increase surveillance and enforcement of penalties to deter illegal activities that may impact the ecological community.</b>	a. Improve surveillance for illegal activities that impact the ecological community, including in approved development areas (e.g. ski resorts, hydro leased areas).	Moderate	Moderate
	b. Ensure that appropriate penalties are applied for illegal activities that damage the ecological community.	Moderate	Moderate
<b>Action 5 - RESOURCE USE</b>	<b>Tasks to avoid new impacts from resource use and minimise impacts where they do occur.</b>	<b>Priority rating</b>	
		<b>ACT/NSW/VIC</b>	<b>TAS</b>
<b>5.1 Avoid impacts from resource use (e.g. peat, <i>Sphagnum</i> and timber harvesting, groundwater extraction), and mitigate past impacts, where possible.</b>	a. For National Parks, State forests and other public land, prevent new resource use that will damage the ecological community.	Moderate	Highest
	b. Minimise the impacts of resource use where it already occurs or has previously occurred in or adjacent to the ecological community (i.e. fence, buffer, prevent weed introduction and rehabilitate).	Low-moderate	Low-moderate

	c. Develop and/or implement guidelines for resource management (including forestry) and other planning mechanisms to ensure resource use and regeneration activities occur over time and develop a temporal-mosaic within sub-catchments that contain the ecological community.	Moderate	Moderate
	d. Work with landholders to minimise the impacts of resource use on the ecological community.	Low-moderate	Moderate
<b>5.2 Increase compliance and enforcement for illegal resource use.</b>	a. Improve surveillance and compliance for illegal resource use.	Moderate	Moderate
	b. Ensure that appropriate penalties are applied for illegal activities that damage the ecological community.	Low-moderate	Low-moderate

<b>Strategy 2. MAINTAIN OR ENHANCE CONDITION OF THE ECOLOGICAL COMMUNITY</b>			
<b>Action 6 - CLIMATE CHANGE</b>	<b>Tasks to support resilience and adaptation to climate change impacts</b>	<b>Priority rating</b>	
		<b>ACT/NSW/VIC</b>	<b>TAS</b>
<b>6.1 Implement Actions 1-5 under Strategy 1 to support resilience and adaptation to climate change impacts.</b>	Implementing actions under Strategy 1 to manage and reduce the impacts of threats will contribute to making the ecological community more resilient to climate change. These actions are crucial to maintaining the extent and condition of the ecological community.	Highest	Highest



<b>6.2 Identify other potential climate change impacts and investigate latest research and techniques to combat them at a local scale.</b>	a. Further develop and use climate models to identify threats to the ecological community from climate change impacts in different parts of the landscape to identify where control of invasive plants and animals will be most critical.	Low-moderate	Moderate
	b. Develop a climate change impact conceptual model of risks to the ecological community and revise regularly as impacts and feedback mechanisms are identified.	Low-moderate	Moderate
	c. Keep up to date with new research and techniques for local scale amelioration of climate change impacts in high altitude environments and undertake trials as appropriate.	Low-moderate	Low-moderate
	d. Identify characteristics of the ecological community that may make some patches more resilient to UV-B (e.g. greater shrub cover, aspect, shading proximity, snow cover duration) and consider this and model these variables in rehabilitation/ restoration triage spatial fire protection planning.	Moderate	Low-moderate
	e. Monitor effects of UV-B and if possible, develop management responses.	Moderate	Low
<b>Action 7 - REHABILITATE CATCHMENTS</b>	<b>Tasks to rehabilitate Alps catchments and restore the ecological community</b>	<b>Priority rating</b>	
		<b>ACT/NSW/VIC</b>	<b>TAS</b>
<b>7.1 Implement Actions 1-5 under Strategy 1 to assist restoring catchments to maintain the hydrological processes upon which the ecological community depends.</b>	When implementing Actions 1-5 to manage and reduce threats to the ecological community, undertake broader efforts across the Alps/Tasmanian highland catchments. The health of the broader catchments is crucial to maintaining and restoring the hydrological processes relevant to the ecological community (and vice versa).	Highest	Highest

<b>7.2 Rehabilitate and restore flows to damaged areas of the ecological community (e.g. from fire, historic grazing, infrastructure damage, areas containing erosion tunnels, flow line incisions and bog collapse).</b>	a. Partition damaged areas to minimise cumulative impacts of threats to other areas.	Low	Low-Moderate
	b. Implement management responses for fire affected areas.	Moderate	Moderate
	c. Use appropriate methods where required to slow and spread surface water inundation to ensure damage to the ecological community does not occur.	Moderate	Low-Moderate
	d. Where possible, remove or modify artificial barriers that impede natural flow (e.g. hydro drains, weirs and artificial dams used for stock) ensuring further damage to the ecological community does not occur and that appropriate protection is in place to prevent aquatic predator access.	Moderate	Moderate
	e. Identify and assess disturbances within local and wider catchments that impact on hydrological function which may also impact the ecological community.	Low	Low
<b>7.3 Develop rehabilitation management methods for the ecological community.</b>	a. Continue to trial and monitor existing rehabilitation works on patches of the ecological community recovering from past fire events and grazing.	Moderate	Low
	b. Undertake research into the biology and ecology of key species in the ecological community to determine how they can be restored or recovered.	Moderate	Low
	c. Undertake restorative trials and revegetation works to assist bog recovery after stochastic events.	High (after significant disturbance)	Low
	d. Develop practical restoration guidelines, including for broader catchment level restoration.	Low-moderate	High

Strategy 3. IMPROVE KNOWLEDGE, REVIEW AND ADAPT MANAGEMENT			
Action 8 - KNOWLEDGE	Tasks to improve knowledge	Priority	
		ACT/NSW/VIC	TAS
<b>8.1 Improve mapping of the ecological community.</b>	a. In conjunction with field research (Action 8.2), update mapping to cover all known occurrences of the ecological community and identify highest priority areas for recovery, fire history, invasive species and nearby major infrastructure, potentially using a central repository for spatial data.	Moderate	Highest
	b. Consolidate existing mapping data; provide a baseline from which changes to the extent and condition of the ecological community can be monitored (see also Task 8.2c).	Moderate-high	Moderate-high
	c. Support development of technology and methods to accurately map the ecological community across its range using remote sensing.	Moderate - high	Highest
	d. Survey and map extent and condition in representative areas for 5 yearly review periods (consistent with the tasks in Action 8.2, particularly Task 8.2d).	Moderate-high	Moderate-high
<b>8.2 Increase field research and monitoring.</b>	a. Undertake alps-wide remote sensing at 5 year intervals to monitor extent of the ecological community across the landscape and help determine catchment-scale changes (see also Action 8.1).	Moderate-high	Moderate-high
	b. Identify and develop an agreed method for determining condition of the ecological community (consider flora, fauna and non-biotic indicators) and determine an acceptable baseline condition rating for an appropriate sample of patches.	Highest	Highest
	c. Continue support for established long-term monitoring programs.	Moderate	High

	d. Undertake annual monitoring of an appropriate sample of patches of the ecological community to collect data and monitor changes in local hydrology regimes; species composition and diversity (include fauna); identify new threats; determine success or setbacks in threat abatement; recommend reprioritisation of actions for specific locations; improve understanding of the causes of change in the ecological community and the drivers and mechanisms of changes.	Moderate-high	Moderate-high
<b>8.3 Improve knowledge associated with threat abatement techniques and effectiveness.</b>	a. Maintain and enhance forums for sharing of latest knowledge amongst Alps managers on threats, threat abatement and techniques, e.g. Alps management workshops, science forums.	Moderate-high	Moderate- high
	b. Develop all-of-Alps and Tasmania repository for relevant information on threats, threat abatement and the ecological community (see also Task 8.1a).	Moderate-high	Moderate-high
<b>Action 9 – MANAGE PLAN</b>	<b>Tasks to coordinate, implement, review and report of progress of the Recovery plan</b>	<b>Priority</b>	
		<b>ACT/NSW/VIC</b>	<b>TAS</b>
<b>9.1 Coordinate implementation.</b>	a. Establish a recovery team, with functional, regional sub-groups where appropriate, in accordance with agreed Terms of Reference.	Low-moderate	Moderate
	b. Appoint a recovery program coordinator to facilitate operations of the recovery team.	Low	Low
	c. Ensure the contents of the national Recovery Plan, particularly the actions and tasks, are incorporated into other relevant management plans as they are revised (e.g. park and forest management plans, threat management plans).	Moderate-high	Moderate- high
	d. Recovery team (or other) to prepare annual reports on progress against objectives and performance criteria, and recommend changes in recovery priorities based on monitoring and other new information.	Low-moderate	Low-moderate
	e. Develop mechanisms for sharing information, potentially including databases, to facilitate responsive and informed decision-making (e.g. see also Tasks 8.1a and 8.3b).	Moderate	Moderate

	f. Review mid-term progress of the Recovery Plan against the objectives in year 5.	Moderate	Moderate
<b>Action 10 - COMMUNICATION</b>	<b>Tasks to foster effective collaboration and knowledge transfer</b>	<b>Priority</b>	
		<b>ACT/NSW/VIC</b>	<b>TAS</b>
<b>10.1 Secure partnerships and resources for implementation.</b>	a. Maintain relationships with existing key delivery partners.	Moderate - high	Moderate-high
	b. Identify and target new partnerships for effective delivery of actions.	Moderate-high	Moderate-high
	c. Identify and secure funding to support implementation of actions.	Highest	Highest
	d. Continue to involve volunteers in as many aspects of implementation as possible, providing safe, supported and engaging opportunities.	Moderate	Moderate
	e. Provide opportunities for local Indigenous community engagement in implementation and other biodiversity conservation.	Moderate-high	Moderate-high
<b>10.2 Communicate effectively with partners, stakeholders and the community.</b>	a. Disseminate the recovery plan widely using a range of media.	High	High
	b. Develop and implement a communications plan to service the information requirements of a range of partners and stakeholders.	Moderate-high	Moderate-high
	c. Disseminate new information widely, including relevant managers of public land, water, flora and fauna in each jurisdiction, including findings from research, monitoring, mapping etc., using a range of media.	High	High

## 6. Implementation

The Alpine *Sphagnum* Bogs and Associated Fens ecological community has a limited distribution and is scattered across its range. The majority of examples of the ecological community are found in areas under conservation tenure, usually in national parks. Therefore, this recovery plan and its supporting background information document are intended as a key resource for park management agencies, to guide and assist actions that support the recovery of the ecological community. Ideally, the priority actions identified in the plan will be incorporated into future versions of park management plans, as well as other key management plans, such as those for State Forests and those dealing specifically with key threats to the ecological community, such as management of feral horses.

This Recovery Plan is also intended to guide project design, delivery and funding decisions. For example, projects consistent with a national recovery plan for a listed species or ecological community are excellent targets for funding under programmes such as the National Landcare Programme and the Green Army programme. Regional investment through such programmes is necessary to support the implementation of the recovery plan across the national range.

### 6.1 Projected funding needs and timing

Overall, implementation of all of the actions in this recovery plan are expected to cost around \$10.79 million annually for ACT, NSW and Victoria combined, and to be implemented over five years with a total cost of about \$53.95 million (Table 3).

The implementation of actions in Tasmania is expected to cost \$3.6 million annually, with a total cost over five years of \$18 million, assuming costs are the same annually (Table 4).

Indicative funding for ACT, NSW and Victoria for implementation of recovery plan actions is outlined in Table 3 below. These costings have been derived from the whole-of-Alps estimates provided to the Australian Government in the Caring for our Australian Alps Catchment report (Worboys *et al.*, 2011) to implement six priority landscape-scale actions that are consistent with the actions in this recovery plan:

- 1) Halting catchment degradation
- 2) Investing in resilient ecosystems
- 3) Adapting to new climates
- 4) Investing in management innovation
- 5) Investing in people and communities, and
- 6) Researching for better catchments.

The report details cost-specific targets under each priority action. Where a target in the report is consistent with an action identified in the recovery plan, the cost of managing that target has been included in the cost against the recovery action in Tables 3 and 4. Where a target under a priority action in the catchment report does not have a corresponding action in the Recovery Plan, the cost for that target has been excluded.

The Caring for our Australian Alps Catchment report includes additional costs appropriate to 'whole-of-Alps' catchment management and are not covered by the recovery plan. This does not exclude the need for establishment and follow-up activities to be undertaken under the recovery plan, just that they are not specifically identified and costed here. These additional costs are:

- A start-up period of two years at a total cost of \$3 million to cover whole-of-Alps project planning, environmental impact assessments, jurisdictional approvals and support the cost of administrative and field equipment.
- An eight year 'follow-up' period for adequate, ongoing control of threats at a total estimated cost of \$35 million.

The Caring for our Australian Alps Catchment report also noted that inaction could be costly. Inaction may jeopardise the ability for Alps catchments, including the ecological community, to provide water generation that was estimated in 2005 to be worth \$9.5 billion to Australia's annual economy (Worboys *et al.*, 2011).

Costing estimates for the report were developed in consultation with ACT, NSW and Victorian Alps management agencies. Provision of funds necessary to implement actions is subject to budgetary and other constraints affecting the parties involved.

**Table 3: Indicative funding required for the implementation of actions in ACT, NSW and Victoria**

Relevant priority action from Caring for Our Australian Alps Catchment	Description	Relevant recovery plan actions/tasks	Annual cost estimate
Halting catchment degradation	Management of invasive weeds and feral animals	A2.1 A2.2 A6.1 A7.1	\$5,838,000
Investing in resilient ecosystems	Revegetate selected wetlands, restore soil eroded areas	A2.2 A3.1 A7.2 A7.3	\$1,043,000
Adapting to new climates	Undertake fire management research, post-fire restoration, manage visitor impacts	A1.1 A4.1 A4.2 A4.3 A5.1 A5.2 A6.2 A7.2 A7.3 A8.2	\$886,000
Investing in management innovation	Management and operational data, decision making, risk management, staff training	A1.1 A2.4 A8.1 A8.2 A10.1 A10.2	\$886,000
Investing in people and communities	Accessible information, connectivity, conservation partnerships, indigenous participation	A2.1 A4.2 A10.1 A10.2	\$156,000
Researching for better catchments	Baseline and change in condition data, adaptive management	A1.1 A2.2 A2.4 A3.1 A4.2 A5.1 A6.2 A8.1 A8.2 A9.1	\$1,981,000
<b>Total annual cost:</b>			<b>\$10,790,000</b>

Figures are derived from page 132-136 of the Caring for our Australian Alps Catchment report (Worboys *et al.* 2011) and have been adjusted for inflation (rounded to the nearest \$1,000) using the [Reserve Bank of Australia Inflation Calculator](#). The costs are not inclusive for A.2.3: Minimise impacts from invasive carnivores. Although there is a target for invasive carnivores, it is not in relation to direct impacts to the ecological community, but for unquantified, indirect impacts due to impacts on overall biodiversity.



**Table 4: Indicative funding required for the implementation of actions in Tasmania.**

<b>Relevant priority action from Caring for Our Australian Alps Catchment</b>	<b>Description</b>	<b>Relevant recovery plan actions</b>	<b>Annual cost estimate</b>
Halting catchment degradation	Management of invasive weeds and feral animals	A2.1 A2.2 A6.1 A7.1	\$1,946,000
Investing in resilient ecosystems	Revegetate selected wetlands, restore soil eroded areas	A2.2 A3.1 A7.2 A7.3	\$347,667
Adapting to new climates	Undertake fire management research, post-fire restoration, manage visitor impacts	A1.1 A4.1 A4.2 A4.3 A5.1 A5.2 A6.2 A7.2 A7.3 A8.2	\$295,332
Investing in management innovation	Management and operational data, decision making, risk management, staff training	A1.1 A2.4 A8.1 A8.2 A10.1 A10.2	\$295,332
Investing in people and communities	Accessible information, connectivity, conservation partnerships, indigenous participation	A2.1 A4.2 A10.1 A10.2	\$52,000
Researching for better catchments	Baseline and change in condition data, adaptive management	A1.1 A2.2 A2.4 A3.1 A4.2 A5.1 A6.2 A8.1 A8.2 A9.1	\$660,332
<b>Total annual cost:</b>			<b>\$3,596,663</b>

## 6.2 Monitoring, evaluation, reporting and review

This plan is intended to be in force for 10 years. Review of progress toward achieving the objectives of the plan is required in year 5. Full review and potential revision of the plan should occur in year 10.

A range of activities to address monitoring and reporting are also identified in Actions 8, 9 and 10 (Table 2). They include research and analysis, collation and reporting of information, and communication of the information with stakeholders, particularly land managers and community groups.

## 6.3 Guide for decision makers

Under the EPBC Act, or other national environmental legislation as may apply at the time an activity is proposed, any person proposing to undertake actions that may have a significant impact on any listed threatened species or ecological community should consider whether the action requires EPBC Act assessment and approval. Further advice on the EPBC Act is available on the [Department of the Environment website](#).

Actions that could **result in any of the following** may result in a significant impact on the Alpine *Sphagnum* Bogs and Associated Fens ecological community:

- Reduction in community extent or condition
- Reduction in range or extent of associated species or threatened species
- Introduction of, spread or reinvasion of weeds or disease
- Damage to the community by disturbance, compression, cutting, burning regimes or trampling and grazing by introduced herbivores
- Alteration of catchment and / or hydrological processes (including eutrophication), alteration of the floral and faunal components of the community.

For further information on Management and conservation practices, please refer to the background information document.

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