National Recovery Plan for the Hoary Sunray *Leucochrysum albicans* var. *tricolor*

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This Recovery Plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be 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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Cover photograph: Hoary Sunray *Leucochrysum albicans* var. *tricolor* at Ballyrogan Victoria by Ian McCann © Department of Sustainability and Environment.

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Summary

The Hoary Sunray *Leucochrysum albicans* var*. tricolor* is a small, perennial paper daisy endemic to south-eastern Australia, where it occurs in New South Wales, the Australian Capital Territory, Victoria and Tasmania. Although still widely distributed and numerically abundant, the species has undergone a substantial decline in range and abundance, largely due to degradation and loss of habitat for agriculture, with some losses due to infrastructure and urban development. Many remaining populations are small, highly fragmented, and threatened by weed invasion, competition and further habitat disturbance and loss. The taxon is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act); as Threatened under the Victorian *Flora and Fauna Guarantee Act* 1988; and as Endangered under the Tasmanian *Threatened Species Protection Act* 1995. This national Recovery Plan for the Hoary Sunray is the first recovery plan for the species, and details its distribution, habitat, threats and recovery objectives and actions necessary to ensure its long-term survival.

Species Information

Description

The Hoary Sunray *Leucochrysum albicans* var. *tricolor* is a perennial everlasting daisy belonging to the daisy family Asteraceae. Stems are 10–15 cm tall, and have narrow leaves 2–10 cm long, covered in white cottony hairs. The yellowish flower heads are 2–5 cm in diameter and surrounded by numerous white overlapping ovate-oblong bracts, with the outer layer often tinged purple or brown. The fruits are brown, ovoid, 2–3 mm long, with 14–20 pappus bristles (description from Wilson 1992; Short 1999). Although perennial, the species dies back over summer, when the plant survives as a perennial rootstock. Individual plants probably live for only a few years (Gilfedder & Kirkpatrick 1994b), and plant numbers can fluctuate widely between years (Berechree 2003). The species produces many small, short-lived seeds that are dependent on the presence of bare ground free from heavy competition (particularly from grasses such as Kangaroo Grass *Themeda triandra*) for germination and establishment. In some areas at least, some disturbance is required for successful establishment, and seedlings often appear on areas that have been scraped.

The Hoary Sunray is an obligate out-breeder that is entirely dependant on the transfer of pollen between individuals for successful reproduction. Pollination is effected by many different insects, including bees (Apidae) and flies (Tephritidae) (Berechree 2003). Seed can probably disperse over many kilometres, will germinate fairly rapidly under a wide range of conditions, and can remain viable in the soil for at least a few months, although probably not for long periods (Gilfedder & Kirkpatrick 1994a, b, c). There are, however, differences between the germination and growth of plants from different environments within Tasmania (Gilfedder & Kirkpatrick 1994c) and between Tasmanian plants and mainland plants, with Victorian plants germinating more rapidly than Tasmanian plants (Morgan 1998).

Taxonomy

The Hoary Sunray constitutes part of a variable, polymorphic species (*Leucochrysum albicans*) that has been subject to extensive taxonomic revision (e.g. Wilson 1960; Willis 1972; Cooke 1986; Wilson 1992), and is divided into a number of sub-specific taxa. The Hoary Sunray is presently defined as a variety *L. albicans* var. *tricolor* within *L. albicans* subsp. *albicans* (Wilson 1992; Ross & Walsh, 2003). The taxon listed under the EPBC Act as *L. albicans* var. *tricolor*. It is distinguished from the other varieties within *L. albicans* by its white involucral bracts and narrow, linear-oblanceolate leaves. *Leucochrysum albicans* var. *buffaloensis* occurs only on Mt. Buffalo and has yellow involucral bracts, as does *L. albicans* var. *albicans*, which is widely distributed from Victoria to Queensland.

It is likely that further taxonomic changes will occur regarding Hoary Sunray, given its disjunct distribution. Some populations on the Monaro Tableland in NSW apparently differ from those in other regions, and may possibly be confused with *Leucochrysum albicans* subsp. *alpinum* (R.

Rehwinkel, pers. comm.; D. Eddy Monaro Grasslands Conservation Management Network, pers. comm.). In rare instances, populations typical of var. *tricolor* are apparently intergrading with the yellow-flowered *L. albicans* var. *albicans* (R. Rehwinkel, pers. comm.).

Distribution

The Hoary Sunray is endemic to south-eastern Australia, where it occurs in three geographically separate areas (Figure 1).

In Tasmania, Hoary Sunray is scattered across the midlands, particularly around Ross, Tunbridge and Campbelltown. It also occurs in the north near Stanley and in several locations in the Great Western Tiers. Current distribution includes the Tasmanian South East, Tasmanian Northern Midlands, Tasmanian Central Highlands and King IBRA bioregion (*sensu* DEH 2000). It once occurred in southern Tasmania, between Buckland and Oatlands, on the north coast near Wynyard, in some areas of western Tasmania (GTSpot, Tasmania Parks and Wildlife Service GIS Webserver) and may once have occurred on the west coast (L. Gilfedder, pers. comm.). The taxon is now absent from the Tasmanian Northern Slopes bioregion.

In Victoria, Hoary Sunray occurs in the south-west, between Colac, Inverleigh, Ballarat, Ararat and Hamilton, in the Victorian Volcanic Plain bioregion. It was once more widespread in the region, with records from Port Fairy, Macarthur, Creswick and Mt Cole.

In NSW and ACT, Hoary Sunray currently occurs on the Southern Tablelands and some adjacent areas (e.g. Tarcutta, Bega valley) in an area roughly bounded by Albury, Bega and Goulburn, in the South Eastern Highlands, Australian Alps and Sydney Basin bioregions. It once occurred more widely in inland NSW, with records from near Cobar, Dubbo, Lithgow, Moss Vale and Delegate. The taxon is now absent from the NSW South West Slopes, South Eastern Corner, Cobar Peneplain and Brigalow Belt South bioregions.

Maps showing the distribution of Hoary Sunray are available from the nature conservation agency in each State and Territory in which the taxon occurs.

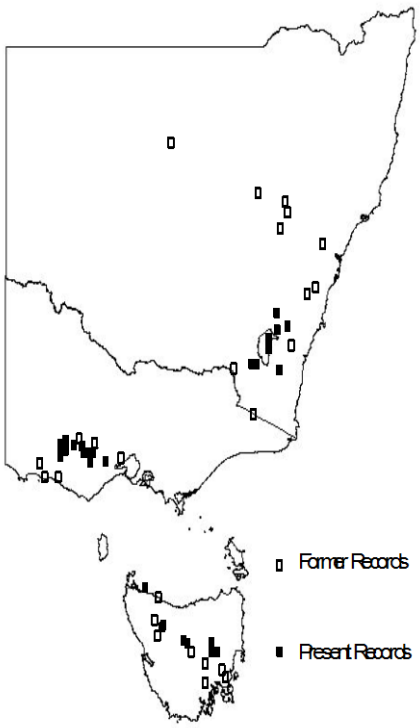

Figure 1. Former and current distribution of Hoary Sunray

Population Information

The Hoary Sunray currently exists in several hundred populations thought to comprise 0.4–1 million plants in total. New South Wales and the ACT both have numerous populations likely to total >200,000 plants, Victoria has about 20 populations containing <40,000 plants (data from Berechree 2003; J. Morgan unpubl. data) and Tasmanian has about 20 populations containing in excess of 100,000 plants (Gilfedder & Kirkpatrick 1994a).

Several significant populations have been identified (Table 1). However, important populations have not yet been determined for this taxon, as there are no data on population location and size for most of the NSW and ACT populations and many populations in Victoria and Tasmania. The collection of baseline data is an important action proposed in this Recovery Plan that will assist in identifying important populations (Action 1.1).

Habitat

The Hoary Sunray occurs in a wide variety of grassland, woodland and forest habitats, generally on relatively heavy soils. In Tasmania, it has a broad climatic and ecological range, occurring in temperate grassy habitats on clay loam soils (Gilfedder 1991; Gilfedder & Kirkpatrick 1994a, b). Sites range from 60–1,160 m altitude, with annual rainfall varying from 450 mm in the midlands to 2,000 mm (occasionally 3,000 mm) in the north-west. In lowland areas, the most common habitat type is grassy woodland of Manna Gum *Eucalyptus viminalis*, Swamp Gum *Eucalyptus ovata* and/or Snow Gum *Eucalyptus pauciflora*, with a grassy layer of *Themeda triandra*, Spear-grasses *Austrostipa* spp. and Long-hair Plume-grass *Dichelachne crinita*. Between the grass tussocks is a rich herb flora including *Convolvulus* sp., Pussy Tails *Ptilotus spathulatus*, Common Woodruff *Asperula conferta*, *Vittadinia muelleri* and Soft Crane's-bill *Geranium potentilloides*. Some shrubs are present, including *Bossiaea* spp. and *Hibbertia hirsuta*. The Hoary Sunray also grows in woodlands of *E. viminalis* or Black Peppermint *Eucalyptus amygdalina* with a diverse heathy and grassy understorey including Bracken *Pteridium esculentum*, Honey Pots *Acrotriche serrulata*, guinea flowers *Hibbertia* spp., Common Flat-pea *Platylobium obtusangulum*, *Hovea heterophylla*, Common Beard-heath *Leucopogon virgatus*, *Themeda triandra*, *Poa hookeri* and *Hemarthria uncinata*. Other habitats include grasslands of Common Tussock-grass *Poa labillardierei* with shrubs including White Correa *Correa alba*, *Pomaderris apetala*, Sweet Bursaria *Bursaria spinosa*, Prickly Moses *Acacia verticillata* and Swamp Paperbark *Melaleuca ericifolia*, along with many weeds. Most of these areas have been substantially modified by a long history of grazing.

In montane areas of Tasmania, the species grows in shrubby grasslands containing *Poa* spp., *Dichelachne rara*, Bristle-grass *Trisetum spicatum*, *Deyeuxia* spp. and the introduced grasses Yorkshire Fog *Holcus lanatus*, Sweet Vernal-grass *Anthoxanthum odoratum*, Cocksfoot *Dactylis glomerata* and Creeping Bent *Agrostis stolenifera*. The diverse herb layer includes *Brachyscome* spp., *Colobanthus apetalus*, Alpine Cotula *Cotula alpina*, *Euphrasia* spp., *Microseris* sp., Silver Carraway *Oreomyrrhis argentea*, Australian Carraway *Oreomyrrhis eriopoda*, Showy Podolepis *Podolepis jaceoides*, *Rhodanthe anthemoides*, Scaly Buttons *Leptorhynchos squamatus*, *Viola cunninghamii* and *Wahlenbergia* spp. Shrubs present include *Coprosma pumila*, *Gaultheria tasmanica*, Alpine Grevillea *Grevillea australis*, *Leucopogon* spp., Thyme Mitrewort *Mitrasacme serpyllifolia*, Carpet Heath *Pentachondra pumilla*, *Richea acerosa*, Alpine Daisy-bush, *Pimelea pygmea* and *Tetratheca procumbens*. Weeds species include *Acetosella vulgaris*, *Cirsium arvense*, clovers *Trifolium* spp. and Cat's Ear *Hypochaeris radicata*.

In Victoria, the Hoary Sunray occurs almost exclusively on acidic clay soils derived from basalt, occasionally on nearby sandy-clay soils derived from sedimentary material (Costin 1999; Costin *et al*. 2001). All known Victorian occurrences are in grassland communities dominated by *Themeda triandra*, *Dichelachne crinita*, *Austrostipa* spp., Short Wallaby-grass *Austrodanthonia carphoides* and other Wallaby-grasses *Austrodanthonia* spp., along with the graminoids Common Bog-rush *Schoenus apogon* and *Juncus* spp. *Leucochrysum albicans* var. *tricolor* is generally found in the spaces between grass tussocks in association with other herb species, often including Blue Devil *Eryngium ovinum*, Lemon Beauty-heads *Calocephalus citreus*, Sheep's Burr *Acaena echinata* and *Leptorhynchos squamatus* (DSE Flora Information System quadrat data).

Table 1. Significant populations of Hoary Sunray

Location	Size	Manager	Comments
Tasmania			
Vale of Belvoir (Conservation Area & private property)	>30,000 plants	DPIW/TLC	conservation covenant; mgt to conserve conservation values
Ross (private property)	>10,000 plants	private	
Middlesex Plain (private property)	>10,000 plants	private	
The Nut State Reserve	~6,000 plants	DPIW	
Township Lagoon Nature Reserve	~1,000 plants	DPIW	
Victoria			
Glenelg Hwy, Streatham	~4,800 plants	VicRoads	
Ararat-Glenthompson Rd, Willaura	~4,700 plants	Ararat Rural City	
Bolac Plains Rd, Woorndoo	~4,600 plants	Moyne Shire	
Hamilton Hwy, Cressy	~3,900 plants	Corangamite Shire	
Rokewood Cemetery & roadsides	~2,000 plants	Golden Plains Shire	¼ pop. in cemetery, ¾ on roadsides
Wickliffe-Willaura Rd, Wickliffe	~2,000 plants	Ararat Rural City	
Lismore-Scarsdale Rd, Wallinduc	~1,900 plants	Golden Plains Shire	
New South Wales			
Snowy Mountains Hwy Adaminaby	5,000+ plants	RTA	pop. extends over many km of roadside & into some adjacent private and public land
Cuumbeun Nature Reserve Queanbeyan	'several thousand'	DECCW	
Queanbeyan Nature Reserve Queanbeyan	'several hundred'	DECCW	
Kuma Nature Reserve Cooma	~100 plants	DECCW	
Brooks Hill Reserve Bungendore	'several hundred'	?	
Gale Crown Reserve Queanbeyan	'several thousand'	?	
Gundary TSR Goulburn	'several hundred'	LHPA	
Top Hut TSR Adaminaby	'several thousand'	LHPA	
John French VC rest area	?	RTA	
Cowpers Creek (private property)	?	private	
Dewsburys Lane (private property)	?	private	
'Lark Hill' (private property)	?	private	
'Milbang' (private property)	?	private	
'Mount Pleasant' (private property)	?	private	
Old Cooma Common Reserve Cooma	'several hundred'	?	crown land under grazing lease
Australian Capital Territory			
ACT CSIRO Limestone Ave	?	Aust. Government	
Campbell Park	?	Dept. of Defence	
Majura Field Firing Range	?	Dept. of Defence	
ACT Campbell Park Offices	?	Dept. of Defence	
Ainslie Majura Nature Reserve	?	ACT Government	
Ainslie CNP	?	ACT Government	
Hackett Horse Paddocks	?	ACT Government	
Kowen Forest	?	ACT Government	
Kowen slope	?	ACT Government	
Rob Roy Foothills	?	ACT Government	
Tuggeranong Hill Nature Reserve	?	ACT Government	
Wanniassa Hills CNP	?	ACT Government	
Majura slope	?	ACT Government	
Mt Ainslie	?	ACT Government	
Mulligan's Flat Nature Reserve	?	ACT Government	
ACT Conder 9	?	private lease	
Newline North	?	private lease	

Abbreviations: ACT = Australian Capital Territory; DECCW = Dept of Environment, Climate Change & Water (NSW); DPIW = Dept. of Primary Industries and Water (Tas); LHPA = Livestock Health and Pest Authority (NSW); RTA = Roads and Traffic Authority (NSW); TLC = Tasmanian Land Conservancy; TSR = Travelling Stock Reserve

In NSW and ACT, Hoary Sunray occurs in grasslands, grassy areas in woodlands and dry open forests, and modified habitats, on a variety of soil types including clays, clay loams, stony and gravely soil. In Canberra, it occurs in semi-urban areas, on roadsides and in Mt Ainslie Nature Reserve, being highly dependent on the presence of bare ground for germination and establishment. Associated species are varied, but commonly include Kangaroo Grass and wallaby grasses *Austrodanthonia* spp. in the ground layer, and often with Yellow Box *Eucalyptus melliodora*, Blakely's Red Gum *Eucalyptus blakelyi*, Red Box *Eucalyptus polyanthemos*, Brittle Gum *Eucalyptus mannifera* or Snow Gum *Eucalyptus pauciflora* where a tree stratum is present. Other species occurring with Hoary Sunray include *Beyeria viscosa*, *Pultenaea* spp., *Acacia rubida*, *Acacia genistifolia*, *Cassinia longifolia*, *Allocasuarina* spp. and *Kunzea parvifolia*.

Within all these habitats, the taxon relies on the presence of bare ground for germination and establishment. In lowland areas, periodic disturbance such as fire creates these bare areas. The Hoary Sunray will also colonise roadsides that have been scraped (R. Rehwinkel, I. Crawford, pers. comm.). In high altitude grasslands (e.g. Monaro region of NSW), there is generally a sparser grass sward with more inter-tussock spaces, which provide suitable sites for germination in the absence of periodic disturbance. Proposed actions include a determination of habitat critical to survival of the Hoary Sunray.

Decline and Threats

Although the Hoary Sunray is still relatively widely distributed and can be locally common in some locations, it has suffered a substantial decline in range (and almost certainly abundance) since European settlement. The taxon has declined from much of its former range in NSW, with remaining records confined to the south-east of the State. In Victoria it has declined or disappeared from many sites on the basalt plains. In Tasmania, Hoary Sunray was once fairly common, but has also declined across much of its range there (Gilfedder & Kirkpatrick 1994a).

Habitat destruction and degradation due to agriculture has undoubtedly been the biggest cause of historical decline. In Victoria, native grasslands once covered about 2 million ha, but have been reduced to only 0.5% of their original extent, with most of the remnants small, isolated and degraded (Costin *et al*. 2001). Most remaining populations occur in more or less degraded linear roadside remnants in an agricultural landscape. In such situations the taxon is vulnerable to alterations in management which have not considered its ecological requirements.

The Hoary Sunray presently survives mostly in areas of remnant habitat such as roadsides that have been fortuitously managed in such a way as to preserve its habitat. However, many of these populations are continuing to decline, and are at risk from a range of threats including:

Habitat destruction, clearing **(High)**

Although bare-ground exposure is important for Hoary Sunray regeneration, gross soil disturbance can destroy adult plants, and disturbance has caused the decline (and probably local extinction) of many populations. The restriction of many populations to roadside remnants especially places the taxon at high risk from road and utilities construction and maintenance. Many plants have already been lost due to roadworks, such as along the Snowy Mountains Highway near Adaminaby in NSW and near Skipton in Victoria. Populations on private land are at risk, especially where land use might change such as from grazing to cropping.

Weed invasion **(High)**

Hoary Sunray is now restricted to small (usually narrow and linear) remnants (often surrounded by agricultural land) that are highly susceptible to weed invasion (Hobbs & Yates 2003). As already noted, Hoary Sunray does not tolerate heavy competition, and is at high risk from the effects of weeds throughout virtually all of its range. Weeds currently threatening the taxon include Cat's Ear, Clovers, Toowoomba Canary-grass *Phalaris aquatica*, Brown-top Bent, Paspalum *Paspalum dilatatum*, Cocksfoot *Dactylus glomerata* and Onion-grass *Romulea rosea*.

Poor Reservation status **(High)**

The Hoary Sunray survives largely outside the reserve system, with few populations protected in reserves, and some of these have probably declined or become locally extinct (Gilfedder 1991).

Lack of appropriate biomass reduction **(High-Low, depending on region)**
The Hoary Sunray requires areas of bare ground to persist. Seedlings had poor survival when they grew close to grass tussocks, but fared far better when they established on bare ground, or areas dominated by herbs (Gilfedder & Kirkpatrick 1994b). Similarly, this may explain the species' persistence and spread in some areas of lightly grazed agricultural land (Gilfedder & Kirkpatrick 1994a, b), where bare soil is constantly exposed. In some areas such as the Monaro region of NSW, high altitude grasslands apparently retain sufficient inter-tussock space in the absence of biomass reduction to allow the taxon to persist. In other areas some periodic disturbance (e.g. fire) is required to create bare ground. In western Victoria, it appears that populations may decline or disappear in the absence of disturbance due to competition from other vegetation (both native and exotic). This requirement may explain the decline of Hoary Sunray in some protected areas in Tasmania, where disturbance is reduced, and other densely-growing species such as *Themeda triandra* can proliferate.

In the past, many roadsides were regularly burnt as a fuel-reduction technique. Recently, there has been a shift to slashing at some sites, which has lead to the loss of bare ground, the dense closure of the grass sward, and the invasion of exotic species. Some sub-populations of Hoary Sunray presently occur in such areas and would appear to be under imminent threat of local extinction (e.g. Skipton-Beaufort Rd Vic).

Inappropriate fire regime **(Moderate)**

Fire is known to be an important disturbance agent in native grasslands, particularly those that rapidly form a closed grass sward in the absence of fire, including the Victorian basalt plains grassland (Morgan 1996). Optimal fire regimes for Hoary Sunray are not known, but it may be predicted that the timing of burning is critical. Presumably, adult Hoary Sunray plants resprout after fire, and seedlings germinate on the bare ground. Burning before plants have set seed may reduce recruitment, an effect which would be particularly notable in areas where plants are short lived and where seeds do not remain viable for long periods. These factors may vary subtly from region to region. Defining optimal disturbance regimes for Hoary Sunray populations is a proposed recovery action.

Grazing by livestock **(High-Low, depending on region)**

The impact of grazing on Hoary Sunray appears to be a complex one, as the tolerance to grazing appears to vary markedly between areas. In Victoria, the Hoary Sunray is generally not known from any grazed areas, and is confined almost exclusively to roadsides. It would appear that grazing is probably a threat in Victoria, and possibly also in NSW and ACT.

By contrast, in Tasmania Hoary Sunray is often abundant in paddocks that are grazed by sheep, cattle or horses, where its persistence in these environments may be attributed to its unpalatability to stock and most insect pests (Gilfedder & Kirkpatrick 1994b). These pastures may be predominantly made up of native species, but Hoary Sunray is sometimes found colonising fertilised, disturbed ground where invasive exotics such as clovers and Cat's Ear grow (Gilfedder & Kirkpatrick 1994b).

Certain grazing regimes are clearly not detrimental to Hoary Sunray populations, and light grazing has probably played an important role in biomass reduction that favours the species. However, alterations in grazing regimes may cause a shift in conditions that no longer favour Hoary Sunray, and allow other species, especially invasive weeds, to establish and exclude it. The different responses observed to grazing may be due to chemical difference in palatability between the plants in Victoria and Tasmania, or it may be due to differences in grazing regimes between the States. The Hoary Sunray does occur in lightly grazed paddocks in the ACT, and light grazing may also be used as a tool for the taxon's management there (EACT 2004). In south-eastern NSW, Hoary Sunray often occurs on roadside reserves but not on adjacent grazing lands, indicating a degree of sensitivity to grazing in this region. However, the reasons for its absence may also be the result of prior cultivation, the application of fertilisers, or perhaps an interaction between fertiliser use and grazing (R. Rehwinkel, pers. comm.).

Small population size **(Moderate-High, depending on region)**

Many small, isolated populations would be subject to the effects of fragmentation on genetic diversity, including the erosion of allele diversity, disruption of pollinator activity, mate-limitation and consequent inbreeding that may lead to inbreeding depression (Costin *et al*. 2001; Berechree 2003). The latter may be particularly severe in self-incompatible species, where

mate-limitation is more pronounced, and individuals may carry a greater 'load' of deleterious alleles than in self compatible species (Berechree 2003). Counts of plant numbers suggest that population size may fluctuate greatly between years, making this taxon especially susceptible to local extinction where populations are small and isolated. Given the fact that the genetic effects of isolation may be becoming manifest, habitat fragmentation is also likely to be a substantial threat in the medium-term future.

Recovery Information

Existing Conservation Measures

A number of initiatives are already in place to conserve the Hoary Sunray. In Victoria, Hoary Sunray has been the subject of substantial genetic and demographic research, including studies aimed at determining whether smaller and/or more isolated populations suffered reduced fitness (Gilfedder & Kirkpatrick 1994; Costin 1999; Costin *et al*. 2001; Berechree 2003). A Public Authority Management Agreement is in place with the Rokewood Cemetery in Victoria to manage the area for its conservation values. The population at the Vale of Belvoir in Tasmania is covered by a conservation covenant, and management prescriptions to manage the area for its conservation values have been prepared.

Recovery Objectives

The overall objective of recovery is to minimise the probability of extinction of Hoary Sunray in the wild and to increase the probability of populations becoming self-sustaining in the long term.

Within the duration of this Recovery Plan, the specific objectives for recovery are to:

1. Determine distribution, abundance and population structure
2. Determine habitat requirements
3. Ensure that key populations and their habitat are protected, monitored and managed appropriately
4. Manage threats to populations
5. Identify key biological characteristics
6. Determine growth rates and viability of populations
7. Build community support for conservation

Program Implementation and Evaluation

This Recovery Plan guides recovery actions for the Hoary Sunray and will be implemented and managed (subject to the availability of funds) by the relevant nature conservation agency in each State/Territory, supported by other agencies, educational institutions, regional natural resource management authorities and community groups as appropriate. Technical, scientific, habitat management or education components of the Recovery Plan will be referred to specialist groups on research, *in situ* management, community education and cultivation as required. Contact will be maintained between the State agencies on recovery issues concerning the Hoary Sunray. The Recovery Plan will run for a maximum of five years from the date of its adoption under the EPBC Act, and will be reviewed and revised within five years of the date of its adoption.

Recovery Actions and Performance Criteria

Action	Description	Performance Criteria
Specific Objective 1: Determine distribution, abundance and population structure		
1.1	Undertake surveys to determine area, extent, number, size and structure of populations, and monitor populations to detect significant changes. **Responsibility: DSE, DPIPWE, DECCW, TMS**	• Data for 20 populations (especially in NSW & ACT) across total range analysed and repeatedly monitored.
1.2	Undertake genetic investigation to determine taxonomic status of populations. **Responsibility: DSE, DPIPWE, DECCW, TMS, RBG**	• Plants from populations across total range investigated for genetic structuring.
Specific Objective 2: Determine habitat requirements		
2.1	Survey known habitat & collect floristic and environmental information relevant to community ecology & condition. **Responsibility: DSE, DPIPWE, DECCW**	• Species/habitat specific survey design prepared. • Habitat critical to survival mapped for 10 populations across range.
2.2	Identify and survey potential habitat, using ecological and bioclimatic information to indicate habitat preference. **Responsibility: DSE, DPIPWE, DECCW, TMS**	• Potential habitat surveyed at five sites. • Predictive model for potential habitat developed & tested at three sites.
Specific Objective 3: Ensure that all populations and their habitat are protected and managed appropriately		
3.1	Protect populations on public land. This action is of particular importance in Victoria, where almost all populations occur on roadsides. **Responsibility: DSE, DPIPWE, DECCW, TMS, LHPAs**	• Actions to protect species incorporated in relevant management plans. • Public Authority Management Agreements or other statutory protection achieved for ten sites.
3.2	Protect populations on private land. This action is of particular importance in Tasmania, where important populations occur on private agricultural land. **Responsibility: DPIPWE, DECCW, CMAs, NGOs**	• Five NSW sites on private land targeted for incentive funding (fencing, management changes) or other private land conservation mechanisms • Important populations on private land have effective statutory protection.
Specific Objective 4: Manage threats to populations		
4.1	Control threats from pest plants. **Responsibility: DSE, DPIPWE, DECCW, TMS**	• Measurable decline in invasive species at ten treated sites.
4.2	Identify disturbance regimes such as fire, soil disturbance and grazing to maintain habitat. **Responsibility: DSE, DPIPWE, DECCW**	• Monitoring and disturbance trials set up. • Management prescriptions for ecological disturbance in regions prepared.
4.3	Implement appropriate disturbance regimes, including protection from disturbance where required. **Responsibility: DSE, DPIPWE, DECC, TMS**	• Management prescriptions for ecological disturbance (including protection where required) implemented at 10 sites.
Specific Objective 5: Identify key biological characteristics		
5.1	Evaluate current reproductive status, seed bank status, longevity, fecundity and recruitment levels. **Responsibility: DSE, DPIPWE, DECCW, TMS**	• Reproductive ecology and regenerative potential quantified for four representative sites. • Seed bank potential quantified for 10 representative sites.
5.2	Identify key stimuli for seed germination requirements. **Responsibility: DSE, DPIPWE, DECCW, TMS**	• Stimuli for recruitment identified. • Management strategies identified to maintain, enhance or restore ecological processes.
Specific Objective 6: Determine the growth rates and viability of populations		
6.1	Measure population trends and responses against recovery actions by undertaking monitoring within an adaptive management framework. **Responsibility: DSE, DPIPWE, DECCW, TMS**	• Techniques for monitoring developed and implemented at 20 sites across range. • Population growth rates determined and Population Viability Analysis completed for populations.
Specific Objective 7: Build community support for conservation		
7.1	Identify opportunities for community involvement in the conservation of the Hoary Sunray. **Responsibility: DSE, DPIPWE, DECCW, TMS, CMAs**	• Community nature conservation groups, Landcare groups and conservation management networks aware of the species and support its conservation.

Abbreviations: CMA – Catchment Management Authorities (NSW); DECCW – Dept of Environment, Climate Change & Water (NSW); DPIPWE – Dept of Primary Industries, Parks, Water & Environment (Tas); DSE – Dept of Sustainability & Environment (Vic); LHPA – Livestock Health & Pest Authorities (NSW); NGO – non-government agencies; TMS – Territory & Municipal Services(ACT)

Management Practices

The philosophy of the strategy for recovery is habitat conservation, restoration and management combined with an understanding of the ecological and biological requirements of Hoary Sunray. The emphasis is on using knowledge to better implement *in situ* management techniques that protect populations and promote regeneration and recruitment. To achieve this, recovery actions are primarily structured to (i) acquire baseline data, (ii) assess habitat condition including ecological and biological function, (iii) monitor and protect populations to maintain or improve population growth, (iv) manage relevant threats and (v) to engage the community in recovery actions.

On-ground site management will aim to mitigate threatening processes and thereby insure against extinction. Major threats requiring management include accidental destruction, competition from pest plants, inappropriate fire regimes and grazing. A range of strategies will be necessary to alleviate these threats including weed control and fire management. Broadscale protection measures applicable to all populations include legal protection of sites, habitat retention and liaison with land managers including private landholders. In addition, searches of known and potential habitat should continue to better define the distributions and size of populations.

The Recovery Plan also advocates strategies to fill some of the major gaps in our knowledge to date. These include an understanding of the mechanisms underlying recruitment and regeneration. Successful *in situ* population management will be founded on understanding the relationships between Hoary Sunray and associated flora, and its response to environmental processes. These are directly linked to biological function and are thus vital to recovery. Demographic censusing will be necessary to gather life history information and to monitor the success of particular management actions. Community participation in recovery actions will be sought, particularly in regard to recovery team membership and implementation of on-ground works.

Biodiversity Benefits

The Recovery Plan includes a number of potential biodiversity benefits for other species and vegetation communities. Principally, this will be through the protection and management of habitat. The adoption of broad-scale management techniques and collection of baseline data will also benefit a number of other threatened plants growing in association with Hoary Sunray, particularly those species with similar life forms and/or flowering responses.

Other threatened plants occurring with Hoary Sunray include Button Wrinklewort *Rutidosis leptorrhynchoides* (Endangered), Monaro Golden Daisy *Rutidosis leiolepis* (Vulnerable), Small Purple Pea *Swainsona recta* (Endangered), Fragrant Leek-orchid *Prasophyllum suaveolens* (Endangered) and Plains Rice-flower *Pimelea spinescens* subsp. *spinescens* (Vulnerable). Management for Hoary Sunray will also protect these species and their habitats. The Hoary Sunray also occurs in EPBC Act-listed endangered ecological communities including Natural Temperate Grassland of the Southern Tablelands of NSW and the ACT, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, and Natural Temperate Grassland of the Victorian Volcanic Plain. Hoary Sunray also occurs in sites with the following threatened fauna species: Striped Legless Lizard *Delma impar* (Vulnerable), Grassland Earless Dragon *Tympanocryptis pinguicolla* (Endangered) and Golden Sun Moth *Synemon plana* (Critically Endangered). Actions benefiting Hoary Sunray may have positive effects on some of these species. The Recovery Plan will also provide an important public education role as threatened flora have the potential to act as ‘flagship species’ for highlighting broader nature conservation and biodiversity issues such as land clearing, grazing, weed invasions and habitat degradation.

Affected Interests

Hoary Sunray populations occur on sites with varying land tenures, including private land, roadsides, unreserved Crown land (e.g. cemeteries), Travelling Stock Reserves and Nature Reserves, so management is the responsibility of a range of private individuals, local and State government agencies and non-government organisations (Table 1).

Role and Interests of Indigenous People

Indigenous communities on whose traditional lands the Hoary Sunray occurs have been advised, through the relevant regional Indigenous facilitator, of the preparation of this Recovery Plan and invited to be involved in the implementation of the Recovery Plan.

Social and Economic Impacts

The implementation of this Recovery Plan is unlikely to cause any significant adverse social and economic impacts. Some populations occur within parks and reserves where management for biodiversity conservation is already a high priority. With many populations occurring along roadsides, negotiations will be held with local government and relevant transport agencies responsible for their management, supported by negotiation of legal instruments such as Public Authority Management Agreements for protection of key sites and populations. Key populations on private land will be protected through negotiation and voluntary agreements with landowners, supported where possible by incentives available through regional natural resource management authorities.

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Priority, Feasibility and Estimated Costs of Recovery Actions

Action	*Description*	*Priority*	*Feasibility*	*Responsibility*	*Cost estimate*					
					Year 1	Year 2	Year 3	Year 4	Year 5	Total
1	**Distribution, abundance**									
1.1	Surveys	1	100%	DSE, DPIPWE, DECCW, TMS	**$10,000**	**$10,000**	**$10,000**	**$0**	**$0**	**$30,000**
1.2	Taxonomy	2	90%	DSE, DPIPWE, DECCW, TMS	**$0**	**$20,000**	**$20,000**	**$0**	**$0**	**$40,000**
2	**Habitat requirements**									
2.1	Known habitat	1	100%	DSE, DPIPWE, DECCW	**$15,000**	**$15,000**	**$0**	**$0**	**$0**	**$30,000**
2.2	Potential habitat	2	75%	DSE, DPIPWE, DECCW, TMS	**$0**	**$0**	**$15,000**	**$0**	**$0**	**$15,000**
3	**Habitat protection**									
3.1	Public land	1	100%	DSE, DPIPWE, DECCW, TMS, LHPAs	**$5,000**	**$10,000**	**$10,000**	**$5,000**	**$5,000**	**$35,000**
3.2	Private land	1	75%	DPIPWE, DECCW, CMAs, NGOs	**$5,000**	**$5,000**	**$15,000**	**$10,000**	**$10,000**	**$50,000**
4	**Threat management**									
4.1	Pest plant control	1	75%	DSE, DPIPWE, DECCW, TMS	**$15,000**	**$15,000**	**$15,000**	**$15,000**	**$15,000**	**$75,000**
4.2	Disturbance regimes	1	50%	DSE, DPIPWE, DECCW	**$10,000**	**$5,000**	**$5,000**	**$5,000**	**$5,000**	**$30,000**
4.3	Implementation	1	100%	DSE, DPIPWE, DECCW	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$50,000**
5	**Biology**									
5.1	Reproductive status	2	75%	DSE, DPIPWE, DECCW	**$10,000**	**$5,000**	**$5,000**	**$5,000**	**$5,000**	**$30,000**
5.2	Seed germination	2	75%	DSE, DPIPWE, DECCW	**$0**	**$0**	**$5,000**	**$5,000**	**$5,000**	**$15,000**
6	**Population viability**									
6.1	Monitoring	2	100%	DSE, DPIPWE, DECCW	**$10,000**	**$10,000**	**$5,000**	**$5,000**	**$5,000**	**$35,000**
7	**Community support**									
7.1	Community extension	3	100%	DSE, DPIPWE, DECCW	**$2,000**	**$2,000**	**$2,000**	**$2,000**	**$2,000**	**$10,000**
				TOTALS	**$2,000.00**	**$2,000.00**	**$2,000.00**	**$2,000.00**	**$2,000.00**	**$10,000.00**