Survey of Radiata Pine wildlings at Scamander Pine Plantation, northeast Tasmania

December 2007

Prepared for Break O' Day Natural Resource Management

CVA works crew at rehabilitation site (L). Good natural regeneration on former plantation (R).

Nicholas Fitzgerald BSc (Hons).Grad Dip JMS.
Consultant botanist

8 Trevallyn Rd
Launceston TAS 7250

m: 0431 663545
e-mail: TasBotanic@gmail.com

ABN 11 849 546 311

Introduction

The Scamander Pine Plantation is in a bushfire-prone area. Large bushfires in Tasmania's northeast in December 2006 burnt extensive areas of native forest, plus some areas of pine plantation. Some recently harvested areas of radiata pine plantation are now undergoing rehabilitation to native forest, however some pine wildlings are growing in these areas. Radiata pine (*Pinus radiata*) wildlings are also invading native forest from the margins of the plantation. In both situations the resulting vegetation will comprise a mix of native dry sclerophyll forest and exotic radiata pine trees. This mixed vegetation differs from both native forest and pine plantation in terms of vegetation structure, fuel composition and fuel loads. There is a concern that bushfire intensity may be increased by this combination. Furthermore, pine wildlings pose a potential threat to the integrity and habitat value of native vegetation.

The North East Bioregional Network (NEBN) commissioned a report in 2006 entitled'Report on Natural Regeneration, Scamander Plantation, Scamander, Tasmania' by Morgan & Povey (2006). That report identifies the ecological issues related to site rehabilitation and invasive pine wildlings at Scamander Plantation.

> "Preventing spread of pines into surrounding native vegetation, as well as remnants within the site, is the highest priority for management of this site" (Morgan & Povey 2006).

In 2007 NEBN formulated an agreement with plantation owner Rayonier to rehabilitate some sites within former pine plantation back to native forest. On-ground works have principally involved manual removal and herbicide treatment of pine wildlings. Rehabilitation works currently consist of weekly NEBN working bees and occasional Conservation Volunteers Australia (CVA) teams and Mersey Natural Resource Management (MNRM) crews.

As at 19th December 2007 around 864 person-hours (NEBN 340 hours, CVA 432 hours, MNRM 92) of wildling control has been conducted, covering approximately 45 hectares of former plantation at an average of 19.2 hours per hectare.

This survey aims to:

(a) document the effectiveness of recent wilding removal in rehabilitation areas;

(b) map the extent of radiata pine invasion in native forest adjacent to the Scamander Pine Plantation;

(c) identify priorities for future wildling control and site rehabilitation works.

Methodology

Rehabilitation Areas

Eighteen 10x10 metre quadrats were surveyed in areas where pines have been harvested and no replanting has since been undertaken (direct seeding has occurred recently in some sites but is not expected to have any impact on species diversity or cover at this stage). The following variables were recorded: number of mature pines (i.e. bearing cones), number of immature pines (i.e. without cones), number of native tree saplings, cover of native vegetation (to nearest 10%). Nine quadrats were located in areas where no removal of pines has occurred, while nine were in similar situations where weeding of pines has been undertaken in the past three months. Slope and aspect varied between sites. Bedrock was either Mathinna series mudstone-derived or Devonian granite.

Wildlings in Native Forest

Given time constraints and the large perimeter of the plantation area a rapid survey technique was used. Where vehicular access was possible the roads and firebreaks forming the perimeter of the plantation area were surveyed from a vehicle. Some parts of the western and northern boundaries were not surveyed due to either very steep tracks or current harvesting operations. Vehicle-based survey involved making a visual determination of pine density in the margins of native vegetation (i.e. a strip around 10 metres wide beginning on the side of the road/firebreak opposite the current/harvested pine plantation). Densities of immature and mature pines were each mapped based on pre-determined categories of number of pines per 100 metres (0, <1, 1-5, 6-10, 11-20, 21-30, >30).

To determine distance of wildling invasion into native forest fifteen transects were surveyed at various points around the margins of the plantation area. Each 100 x 30 metre transect was perpendicular to the pine plantation boundary, starting from the edge of native forest, so as to record numbers of immature and mature pine wildlings with distance from the plantation.

Results

While the scope of this study precludes extensive data collection and analysis, a number of observations are apparent from the data collected.

Rehabilitation Areas

In former plantation areas, sites that had been weeded generally had less than 5 radiata pines per quadrat (<500/hectare). Two out of three quadrats at the most recently weeded site (one week previously) had no pines. Pine density is variable in unweeded sites. Only one quadrat had fewer than 5 pines while the remainder had more than 10 pines (>1000/hectare) with four of these plots exceeding 30 pines (>3000/hectare). Almost all

the pines in harvested plantation areas are immature, however there are occasional young mature pines which appear to have become established from seed under the plantation canopy and survived harvesting due to their small size.

Native plant diversity is typically in the range 11-20 species per 10 x 10 metre quadrat. More than 20 native species were observed in 3 plots, all on granite bedrock. Ground cover of native vegetation was mostly in the range 60-80%, where this was lower it was due to a large proportion of bare ground rather than coverage of pines.

Wildlings in Native Forest

The highest densities of both mature and immature pines in native forest occur within 20 metres of the forest edge. Excluding transect 9 which is in a heavily pine-invaded bush remnant within the plantation area, density of pines does not exceed 2000/hectare and is typically under 500/hectare.

Pines were found greater than 100 metres from the plantation in 11 of the 15 transects. Pines were observed 150 to 200 metres from the plantation in some places. In two transects pines were observed no more than 20 metres from the plantation.

The density of roadside wildlings is variable. Some limited sections of the eastern boundary of the plantation are free of pine wildlings, while in other places more than 30 pines per 100 metres were observed.

Apart from radiata pine there are few weeds in the vicinity of Scamander Pine Plantation. Foxglove occurs in several areas of former plantation, but will eventually be shaded out by native forest or pine plantation. A population of Spanish heath (*Erica lusitanica*), which is an environmental weed and fire hazard, was observed confined to a short sector of roadside. Several isolated weeds were observed in firebreaks along the eastern boundary of the plantation as a result of illegal dumping of garden refuse.

Discussion

Manual removal of radiata pine in former plantation areas has been successful, with much lower densities of pine compared to the unweeded sites. A small number of pines evidently escaped weeding and pine seedlings have germinated since the weeding operation in some sites. This demonstrates the need for follow-up control of wildlings in previously weeded areas, perhaps one to two years after the initial weeding. Given the varying pine densities it would be sensible to target both small dense patches and large areas of low density in future weeding efforts.

The density and diversity of native plants at most sites is very promising for rehabilitation. In some situations no active revegetation is necessary, in contrast to most cases of plantation rehabilitation (Kasel *et al*. 2005). However supplementing the natural regeneration with direct seeding of native tree and shrub species will be beneficial in most

cases, particularly to speed up the succession from native pioneer species to mature forest species.

Rehabilitation to native forest will lead to reduced wildling invasion of native forest by reducing the pine seed source and reducing the edge area (perimeter) of the plantation, which is where the majority of wildlings originate.

Pine wildlings become established on disturbed ground such as road cuttings more readily than in intact native forest (Williams & Wardle 2007). Therefore the measure of pine density on the margins of native forest does not necessarily reflect pine density within the native forest. Transect surveys show that pine density is typically much higher on the forest margin (within 10-20 metres of the road/firebreak edge) than within the forest. However the measure of roadside pine density does indicate where pines are establishing beyond the plantation and since these wild pines are a potential source of wildling invasion by seed transport into the native forest it provides an indication of where actual or potential threat of native forest invasion occurs.

It is apparent that wildlings are frequently established more than 100 metres into native vegetation. Given the limited observations made beyond 100 metres from the plantation edges it is not known what the maximum distance of invasion is, but it is likely to be several hundred metres at least. Williams & Wardle (2007) note that radiata pine is well adapted to wind dispersal and although most seed travels only short distances, wildlings can occasionally be established up to 3 kilometres away from plantations depending on wind patterns. Yellow-tailed black cockatoos are known to spread pine seed (Muyt 2001), and are likely to be a significant dispersal agent in the Scamander area. The presence of mature pines is of particular concern because the presence of a seed source within native forest may facilitate significant population growth of pine wildlings.

The transects show that although wildlings are most dense at the forest edge, further into the forest they do not necessarily decrease in number with increasing distance from the plantation edge. This may be due to differences in site suitability for pine seedling establishment since it is likely that microsite conditions such as soil moisture, soil mycorrhizae, competition from other plants and light levels will determine the survival of pine seedlings. Also there may be a seed source (i.e. mature pines) distant from the plantation edge. Observations of pine wildlings suggests that shallow gullies and depressions appear to support greater densities of pines than the surrounding slopes; this may be due to seed transport by wind and water preferentially depositing seed in depressions, or increased seedling survivorship due to microsite differences (e.g. soil moisture).

A number of factors appear to be involved in determining the extent of pine invasion. Observation of wildlings at Scamander Plantation suggest that the factors identified by Lindenmeyer & McCarthy (2001) are relevant to this situation: radiata pine wildlings are more common in remnant dry eucalypt forest within plantation landscapes (as opposed to

extensive native forest), where the understorey has limited groundcover vegetation, where the pine plantations have been established for a long time. At Scamander Plantation there appears to be a higher density of wildlings in remnant eucalypt forest within the plantation than in the surrounding forest, and more wildlings in dry forest with an open understorey than in the wetter native forest.

Radiata pine is a relatively slow weed to become established and tends to invade in phases related to seed production and dispersal. Maximum seed production occurs between about 10 and 20 years of age (Williams & Wardle 2007) so if wildling pines are allowed to mature they have significant potential to increase in population density and to spread further (in a stepwise manner). Once pine populations have consolidated in native forest control or eradication will be much more difficult.

A long-term study of radiata pine invasion into dry sclerophyll forest in the Australian Capital Territory (Chilvers & Burdon 1983) showed that pines had a growth rate around 10 times greater than the native eucalypts and a second wave of pine wildlings was becoming established from the earlier wildlings after the adjacent pine plantation had been harvested. The superior growth rate of radiata pine eventually resulted in pines emerging above the eucalypt canopy (Burdon & Chilvers 1994), which has serious implications for the survival of eucalypt forest in such circumstances given the inability of eucalypts to survive in the shady conditions under a pine canopy. Although pine invasion and establishment is relatively slow it may lead eventually to a serious change in forest structure and composition. Additionally, the higher water usage of radiata pine compared to eucalypts reduces water yields from catchments where pines replace eucalypts (Putuhena & Cordery 2000).

At the southern edge of the Scamander Plantation the native forest in places has been subject to recent bushfire. The bushfire has killed most of the smaller pines in these areas, although a number of taller mature pines have survived. Controlled use of low-intensity burns with appropriate frequency is an effective means of controlling smaller pine wildlings in native forest (Gill & Williams 1999) and former plantations undergoing rehabilitation (Kasel *et al*. 2005).

The increase in living and dead biomass associated with established pine populations in native forest is likely to increase fuel loads and therefore result in more intense bushfires. However the relationship between pine invasion of native forest and fire risk is complex and is not sufficiently known, although inferences can be made from bushfire research in native forest and pine plantations. In certain types of dry sclerophyll forest, invasion by pines may actually reduce overall flammability because established pines will replace the more flammable native shrubby or heathy understorey (J. Marsden-Smedley, pers. comm.). However in dry forest with an open understorey, such as *Eucalyptus sieberi* forest bordering the Scamander Plantation, the addition of pines would increase fire risk. Dense mature pines are likely to reduce the rate of spread of a wildfire but increase the intensity

(J. Marsden-Smedley, pers. comm.). Where radiata pine becomes established in eucalypt forest the production of considerable quantities of highly flammable pine litter may increase the fire risk (Williams & Wardle 2007).

Aerial spraying of herbicide has recently been used to control wildings post-harvesting in some coupes in the western part of the Scamander Plantation. This technique is appropriate for sites where pines will be replanted but is not suitable for areas to be regenerated since the indiscriminate use of herbicide kills regenerating native species.

Removal of pine wildings in native forest and rehabilitation of former pine plantations is expected to provide a number of beneficial effects including reducing fire risk, supporting biodiversity and improving water yields.

Recommendations

Rehabilitation Areas

- Continue rehabilitation program (removal of pine wildlings and direct seeding with local native forest species) of former plantation areas. Priority should be rehabilitation of plantation areas adjacent to native forest so as to reduce future pine invasion. Refer to Morgan & Povey (2006) for more details. Several key areas suitable for immediate rehabilitation are identified in the map on page 10. These areas total around 100 hectares and are estimated to require approx 270 days work.
- Conduct small-scale trials of controlled burning to kill pine wildlings and promote native plant regeneration in areas of dense pine regrowth. An area suitable for using this technique is identified in the map on page 10.

Wildlings in Native Forest

- Develop a strategic wildling control program for native forest surrounding the Scamander Pine Plantation. Mature pines should be targeted as a priority and seed cones must be removed from the site.
- Undertake manual control to eradicate low density pine infestations with few mature trees in bushland adjoining the western portion of the Scamander Plantation (e.g. sectors 21 to 28 in the map on page 9). An estimated 550 hectares of bush requires inspection and control of pine where they occur.
- Undertake targeted control of mature pines where established infestations occur in bushland, preferably by cutting pine trees down or alternatively using stem injection or ringbarking techniques (e.g. sectors1 to 6, 7 to 14, 20, 21, 29 on the map on page 9). An estimated 190 hectares of bush potentially has serious pine infestation.
- Liaise with landowners adjacent to eastern boundary to coordinate wildling control on private land, targeting the isolated dense infestations as a priority.
- Investigate use of controlled burning to control denser patches of wildlings in native forest, as a hazard reduction burning programme.

General Recommendations

- Ensure follow-up wildling control occurs at appropriate times (e.g. 1 to 2 years after initial weeding and ongoing over several years).
- Implement monitoring and evaluation of on-ground works (e.g. measures of pine densities, regular photographs at established photo-points) (see Kasel *et al*. 2005).
- Eradicate the relatively small and discrete patch of Spanish heath (see map on page 9).

References

Burdon, J.J. & Chilvers, G.A. (1994) Demographic changes and the development of competition in a native Australian eucalypt forest invaded by exotic pines. *Oecologia*, **97**, 419-423.

Chilvers, G.A. & Burdon, J.J. (1983) Further studies on a native Australian eucalypt forest invaded by exotic pines. *Oecologia*, **59**, 239-245.

Gill, A.M. & Williams, J.E. (1999) Fire regimes and biodiversity: the effects of fragmentation of southeastern Australian eucalypt forests by urbanisiaiton, agriculture and pine plantations. *Forest Ecology and Management*, **85**, 261-278.

Kasel, S., Jewell, C. & Gosby, K. (2005) *Rehabilitation of former pine plantations: a practitioner's manual*. School of Forest and Ecosystem Science, University of Melbourne & Department of Sustainability and Environment, Victoria.

Lindenmeyer, D.B. & McCarthy, M.A. (2001) The spatial distribution of non-native plant invaders in a pine-eucalypt mosaic in south-eastern Australia. *Biological Conservation*, **102**, 77-87.

Morgan, H. & Povey, A. (2006) "Report on Natural Regeneration, Scamander Plantation, Scamander, Tasmania." Bushways Environmental Services.

Muyt, A. (2001) *Bush Invaders of South-East Australia: a guide to the identification and control of environmental weeds found in South-East Australia*. R.G and F.J. Richardson, Victoria.

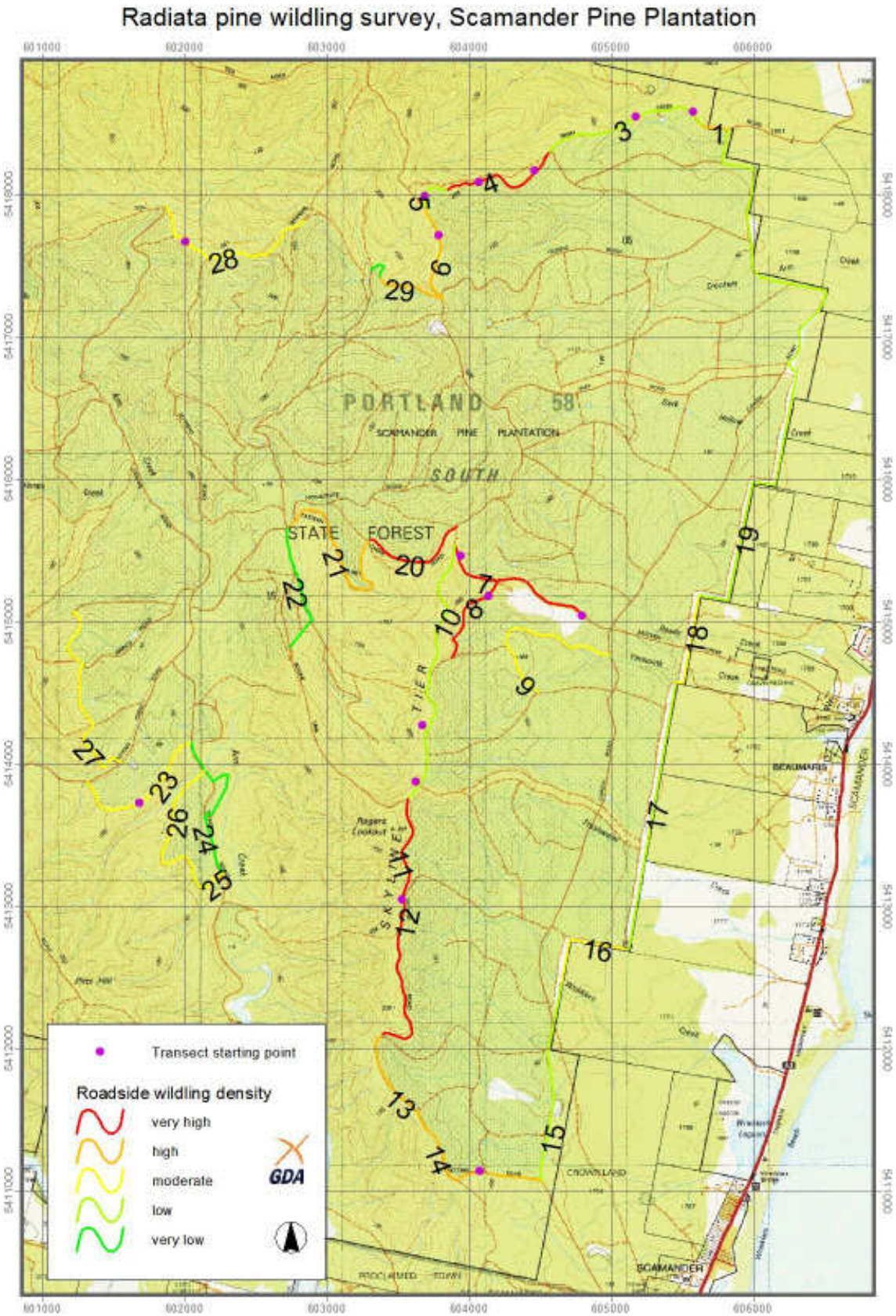
Williams, M.C. & Wardle, G.M. (2007) Pine and eucalypt litterfall in a pine-invaded eucalypt woodland: the role of fire and canopy cover. *Forest Ecology and Management*, **253**, 1-10.

Williams, M.C. & Wardle, G.M. (2007) *Pinus radiata* invasion in Australia: Identifying key knowledge gaps and research directions. *Austral Ecology*, **32**, 721-739.

Acknowledgements

Todd Dudley provided suggestions and fieldwork assistance. Funding was provided by Break O' Day NRM and North East Bioregional Network. GIS data provided by North East Bioregional Network under licence from State of Tasmania.

Appendix 1 - Maps



Priority rehabilitation areas, Scamander Pine Plantation

Appendix 2 – Survey Data

TABLE 1. Quadrat surveys of wildlings in harvested pine plantations.

Quadrat	easting GDA	northing GDA	mature pines	imm. Pines	native trees	native veg % cover	native plant diversity	weeded	threatened species
1	604471	5418050	0	6-10	≤5	80	11-15	3-6 weeks prev	
2	604405	5418021	0	≤5	6-10	80	16-20	3-6 weeks prev	
3	603745	5414541	1	30+	≤5	60	11-15	no	
4	603771	5414322	0	30+	≤5	60	11-15	no	
5	604074	5418072	0	11-20	0	20	6-10	c. 3 months prev	
6	604222	5415231	0	≤5	11-20	70	6-10	c. 3 months prev	
7	603732	5417912	0	≤5	≤5	30	11-15	c. 3 months prev	
8	603770	5417836	0	≤5	≤5	60	21-25	c. 3 months prev	
9	603695	5413890	1	30+	6-10	80	11-15	no	Hierochloe rariflora
10	603755	5414638	0	21-30	11-20	90	11-15	no	Hierochloe rariflora
11	604587	5414929	0	11-20	11-20	90	6-10	no	Skipper habitat
12	603725	5414070	0	30+	30+	60	16-20	no	Hierochloe rariflora
13	604065	5414818	0	≤5	≤5	70	11-15	no	
14	604531	5418212	0	0	0	70	21-25	1 week prev	Skipper habitat
15	604494	5418184	0	0	0	60	16-20	1 week prev	Skipper habitat
16	604146	5415197	0	11-20	11-20	60	21-25	no	Skipper habitat
17	604497	5418178	0	≤5	≤5	70	16-20	1 week prev	Skipper habitat
18	604896	5414830	0	11-20	11-20	70	16-20	no	Skipper habitat

TABLE 2. Road/firebreak surveys of wildlings on plantation boundaries.

SECTION	mature pines per 100m	imm. pines per 100m	density rating	SECTION	mature pines per 100m	imm. pines per 100m	density rating
1	11-20	21-30	high	16	6-10	11-20	moderate
2	0	6-10	low	17	<1	1-5	low
3	6-10	6-10	low	18	6-10	11-20	moderate
4	30+	30+	very high	19	<1	1-5	low
5	1-5	6-10	low	20	11-20	30+	very high
6	6-10	21-30	high	21	<1	30+	high
7	30+	30+	very high	22	0	1-5	very low
8	30+	30+	very high	23	≤5	21-30	moderate
9	11-20	11-20	moderate	24	0	0	very low
10	1-5	1-5	low	25	<1	21-30	moderate
11	30+	21-30	very high	26	<1	11-20	moderate
12	30+	30+	very high	27	1-5	21-30	moderate
13	11-20	21-30	high	28	0	21-30	moderate
14	11-20	21-30	high	29	6-10	30+	high
15	<1	1-5	low	30	0	0	very low

NB: Section numbers are shown on map on page 9

TABLE 3. Transect surveys of wildlings in native forest.

				distance from road/firebreak (metres)					
TRANSECT	easting GDA	northing GDA	TASVEG code	0-10 mature	0-10 immature	10-20 mature	10-20 immature	20-30 mature	20-30 immature
1	605576	5418583	DSO	≤5	6-10	0	6-10	0	0
2	605177	5418551	DSO	≤5	0	0	0	0	0
3	604463	5418171	DSO	6-10	6-10	6-10	≤5	≤5	≤5
4	604053	5418298	DSO	11-20	21-30	11-20	11-20	11-20	11-20
5	603703	5417996	DSO	≤5	0		0	0	0
6	603787	5417716	DSO	≤5	21-30	≤5	6-10	0	≤5
7	603943	5415460	DSO	21-30	21-30	11-20	0	11-20	0
8*	604138	5415179	DSO	6-10	6-10	≤5	0	0	≤5
9	604794	5415041	FWU	30+	21-30	21-30	11-20	21-30	6-10
10**	603673	5414272	DSG	11-20	11-20	0	≤5	0	0
11	603626	5413875	DSG	6-10	0	≤5	≤5	0	6-10
12	603530	5413046	DSG	≤5	6-10	0	≤5	0	≤5
13***	604109	5411291	DSO	≤5	11-20	0	≤5	0	0
14	601661	5413799	DSO	0	6-10	0	0	0	≤5
15			DSO	0	6-10	0	≤5	0	6-10

TRANSECT (cont.)	30-40 mature	30-40 immature	40-50 mature	40-50 immature	50-100 mature	50-100 immature	100+ mature	100+ immature	estimated max distance from road (m)
1	0	0	0	0	0	0	none	none	
2	0	0	≤5	0	≤5	≤5	none	none	
3	0	0	≤5	0	≤5	11-20	moderate	none	200
4	≤5	11-20	0	≤5	≤5	6-10	few	few	
5	0	0	0	0	0	0	none	none	
6	0	≤5	0	0	≤5	≤5	few	few	
7	6-10	6-10	≤5	0	6-10	6-10	none	few	110
8	0	≤5	≤5	6-10	≤5	≤5	lots	lots	
9	21-30	6-10	30+	6-10	30+	30+	few	none	
10	0	0	0	≤5	0	0	none	none	
11	0	≤5	0	≤5	0	6-10	none	few	
12	0	6-10	0	6-10	0	11-20	moderate	none	100-130
13	≤5	0	0	≤5	≤5	0	few	none	
14	0	≤5	≤5	≤5	≤5	21-30	few	lots	130+
15	0	11-20	0	6-10	0	21-30	none	lots	150+

* pine density increases at far end of transect with proximity to road on opposite side of gully
** no pines at end of transect apparently due to exclusion by dense understorey of bulloak (*Allocasuarina littoralis*)
*** most pines along this transect have been killed by a recent fire and therefore not counted