IVG Forest Conservation Report 3D

Report for the Independent Verification Group of the Tasmanian Forests Intergovernmental Agreement on forest fire refugia

Fire Refugia

Introduction

Fire refugia are sites that are subject to much lower fire frequency than the surrounding landscape. These are typically determined by landscape features which influence fire spread and intensity. Fire refugia are important for maintaining vegetation communities which require relatively long fire intervals or low fire intensity and particularly for highly fire sensitive flora and vegetation. It is also postulated that refugia will be increasingly important in the face of projected climate change, and their protection will be an important adaptation strategy. Fire refugia also can act as drought refugia due to their favourable topographic protection.

In this report, we aim to assess the benefits of the proposed ENGO forest reserves in protecting areas of high fire refugia status in Tasmania. The state's diverse vegetation varies substantially in both flammability and ability to tolerate and recover from fire (Jackson 1968). For example, buttongrass moorland and grassy ecosystems recover rapidly from fire, and fire is beneficial in promoting biodiversity. Dry eucalypt forests and woodlands tolerate and recover from fires that occur at a lower frequency, although too frequent burning can substantially alter ecosystem composition, shifting the system towards early- successional species. Wet eucalypt forests tolerate infrequent fires, with return-times on the scale of centuries, which promote regeneration, as is indicated by the even-aged stands found in many of these communities. Rainforests are generally intolerant of fire, and burning may trigger long-lasting or permanent shifts to less fire-sensitive vegetation (Wood *et al.* 2011).

The presence of these varying vegetation types at a location is determined partly by topographic and climatic features which reduce or promote fire spread (Bradstock *et al.* 2010). For example, south-facing slopes and deep valleys are protected from fire, and vegetation communities sensitive to fire are frequently restricted to these refugia. The majority of wildfires in Tasmania occur as the result of human activity, either directly through arson, agricultural burning, prescribed burns or other escaped fires, or indirectly, for example from fallen or damaged powerlines. Therefore, locations more distant from human influence and activity have a lower potential for ignition, and face a reduced impact of fire.

In developing an Index of Fire Refugia status for Tasmania's native vegetation, we sought to highlight ecosystems with vegetation communities that were sensitive to fire, which were offered some topographic protection, and which had a low ignition potential from human activity. These ecosystems are more likely to retain their present community composition and to shelter rarer fire-sensitive taxa (Gill and Bradstock 1995), and would be a valuable addition to the reserve estate.

We aim to tabulate the present degree of reserve protection of areas of high fire-refugia status in Tasmania within nine bioregions, and to determine the additional protection offered by the proposed ENGO reserves at a state-wide, bioregional and reserve scale.

Methods

Fire refugia status of existing and proposed reserves was assessed in three ways; the fire sensitivity of the mapped vegetation, the topographic fire protection offered at a location, and the ignition probability based on local human activity. The units of analysis were polygons produced by intersecting the IBRA 6.1 (Interim Biogeographic Regionalisation of Australia, Thackway and Cresswell 1997) bioregions (Figure 1), the TASVEG 1.3 communities layer, and the IGA forest agreements tenure layer for the state (IGA_RSFINAL1). IGA_RSFINAL1 is an edited version of the Intergovernmental Agreement (IGA) forest agreements layer. The total area is 563,682 ha. This version is the result of several iterations with input from DPIPWE, the IVG and ERIN in November 2011.

The tenure layer describes 11 categories, including the proposed new reserves (Figure 2).

- A1 - Dedicated formal reserve
- A2 - Informal reserve on public land
- P2 - Informal reserve on public land proposed for reservation;
- A3 - Other public land\newline
- P3 - Other public land proposed for reservation
- IP - Indigenous protected area
- PI - Indigenous protected area proposed for reservation
- FR - Private conservation reserve
- PF - Private conservation reserve proposed for reservation
- ZZ - Not attributed (freehold land plus any areas not attributed above)
- PZ - Unattributed areas proposed for reservation

Fire Sensitivity

The fire sensitivity measure was provided by Nick Fitzgerald (DPIPWE), and is based on the work of Dave Taylor (David.Taylor@parks.tas.gov.au) as part of the as-yet unpublished BRAMS (Bushfire Risk Assessment Model System). Each TASVEG community was classified with a value from 1 - 5 on the basis of the ecological effects of a single fire. Under this classification, highly fire sensitive communities such as rainforests are given a high value as they take the longest time to return to their original form, while communities that recover rapidly from burning are given a low value (Figure 3).

Topographic Fire Protection

A topographic fire protection index was derived from *Tasdem25*, a 25m digital elevation model, (Information & Land Services Division Dept. of Primary Industries, Parks, Water & Environment). Three variables of importance to fire spread were included; topographic position index, aspect, and valley depth. Topographic position index describes the landscape in terms of valley, ridge, flat or slope, and was calculated with a 1km window using the *Land facet corridor designer* extension for ArcGIS (Jenness 2011). Aspect describes the north- or south- facing angle of the slope. Valley depth describes the depth and protection level of valleys, and was produced by Matt Webb using the *Relative heights and slope position* algorithm of the *SAGA GIS* software. Fire occurrence in Tasmania was measured using hotspot detections from the MODIS instruments on the Aqua and Terra earth observing satellites, which provide a decade-long data set (Giglio *et al.* 2003). The number of hotspot detections were counted within 2.5km cells across the state, and a generalized linear model was used to establish a relationship between fire occurrence and a combination of the three topographic variables. Low fire occurrence was found to have a significant relationship with southerly aspects, low topographic position, and deep valleys. Model parameters were used to create a single topographic protection index from the input layers, which was scaled to values 0 - 5, with a high value indicating high fire protection status, and a low value indicating low fire protection status. Analysis polygons were assigned with the mean topographic fire protection index value of the raster cells they intersected (Figure 4).

Ignition Probability

Ignition sources in Tasmania are primary of human origin, with lightning playing a relatively minor role (Atkinson *et al.* 2010). Human influence was derived from the Human Footprint Index Version 2 (Sanderson *et al.* 2003), which attempts to measure human influence on ecosystems by combining data on population density, transport density, and land use, all factors known to show correlation with fire ignition (Yang *et al.* 2008, Syphard *et al.* 2007) . High values of the index represent areas strongly modified and influenced by humans, while low values indicate relatively untouched wilderness areas. Analysis polygons were assigned with the mean Human Footprint Index raster values they intersected, which was then scaled to values 0 - 5 (Figure 5).

Fire Refugia Index

All three indices were combined to give a **Fire Refugia Index** value, with vegetation sensitivity and topographic protection given equal weighting, and human ignition probability weighted at 66.6% of the other variables. High values indicating polygons with fire sensitive vegetation, within topographic fire refugia, and with low human ignition probability (Figure 6).

Non-forest vegetation, based on TASVEG codes, was excluded from the fire refugia analysis from this point. For the purposes of classifying proposed reserves with different overall value in terms of fire refugia, the Fire Refugia Index was broken down into three classes, representing the bottom, middle, and top percentiles of the data. This classification enabled a weighted, area-based index (**Fire Refugia Area Index)** to be produced for each reserve describing the relative coverage of low, medium and high fire refugia classes.

FRAI = (Low% + Medium% x 2 + High% x 4)-100

This report contains summaries of the Fire Refugia Index within IBRA bioregions, and for each reserve type. Within each IBRA region, we provide summaries of the area in various land tenures, the area of high Fire Refugia Index within those tenures, and a summary of how much additional refugia area will be protected under the proposed reserves. On the level of individual proposed reserves, we provide two summary tables listing reserves that have the highest mean value in terms of fire refugia status, and those reserves that protect the most high Fire Refugia Index vegetation by area. On the level of individual reserves, we summarise the tenure types the reserves currently contain, and the relative and absolute areas of various fire refugia status within the proposed reserves.

Maps

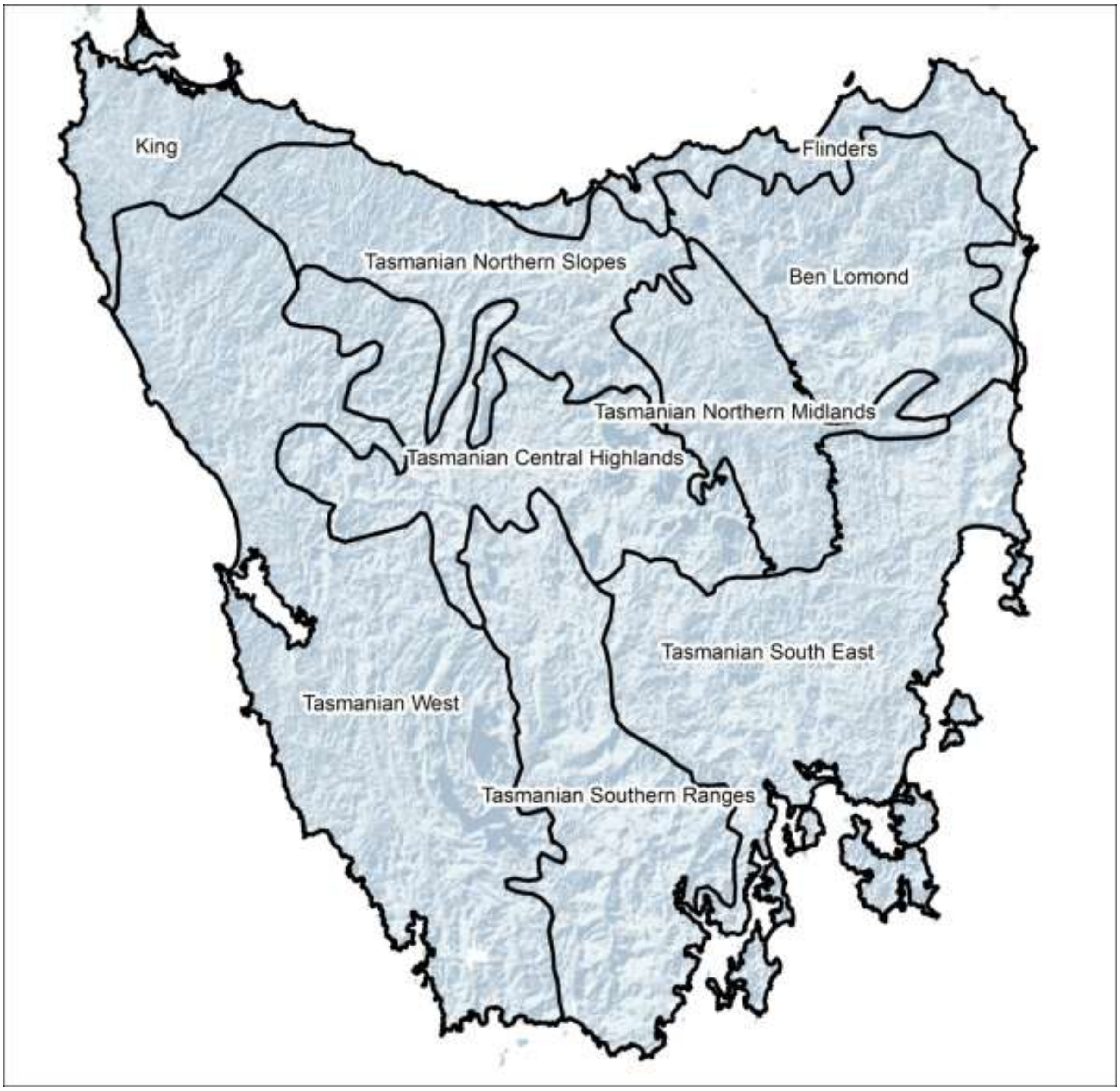

Figure 1 IBRA Bioregions in Tasmania

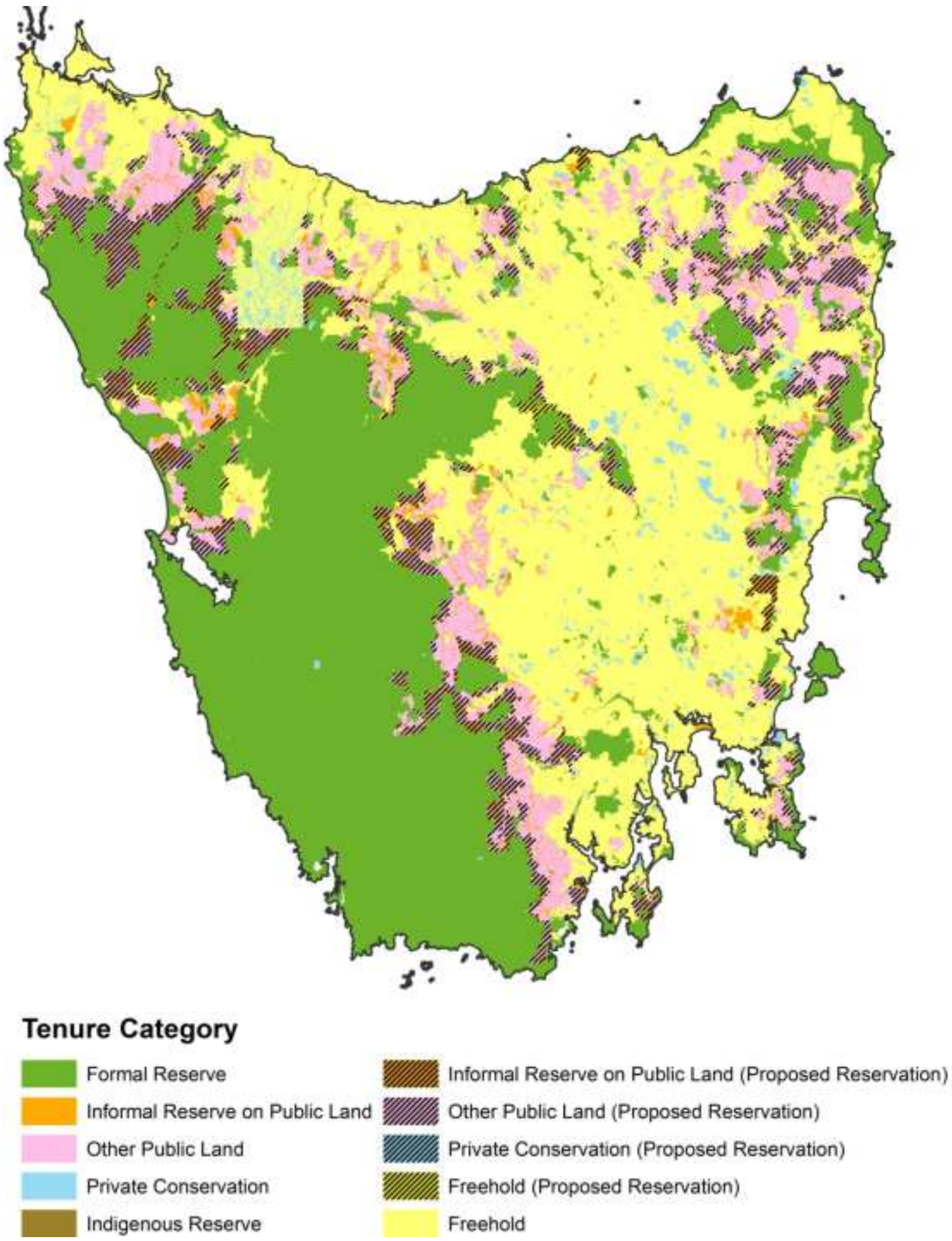

Figure 2 Tenure and Proposed Reserves

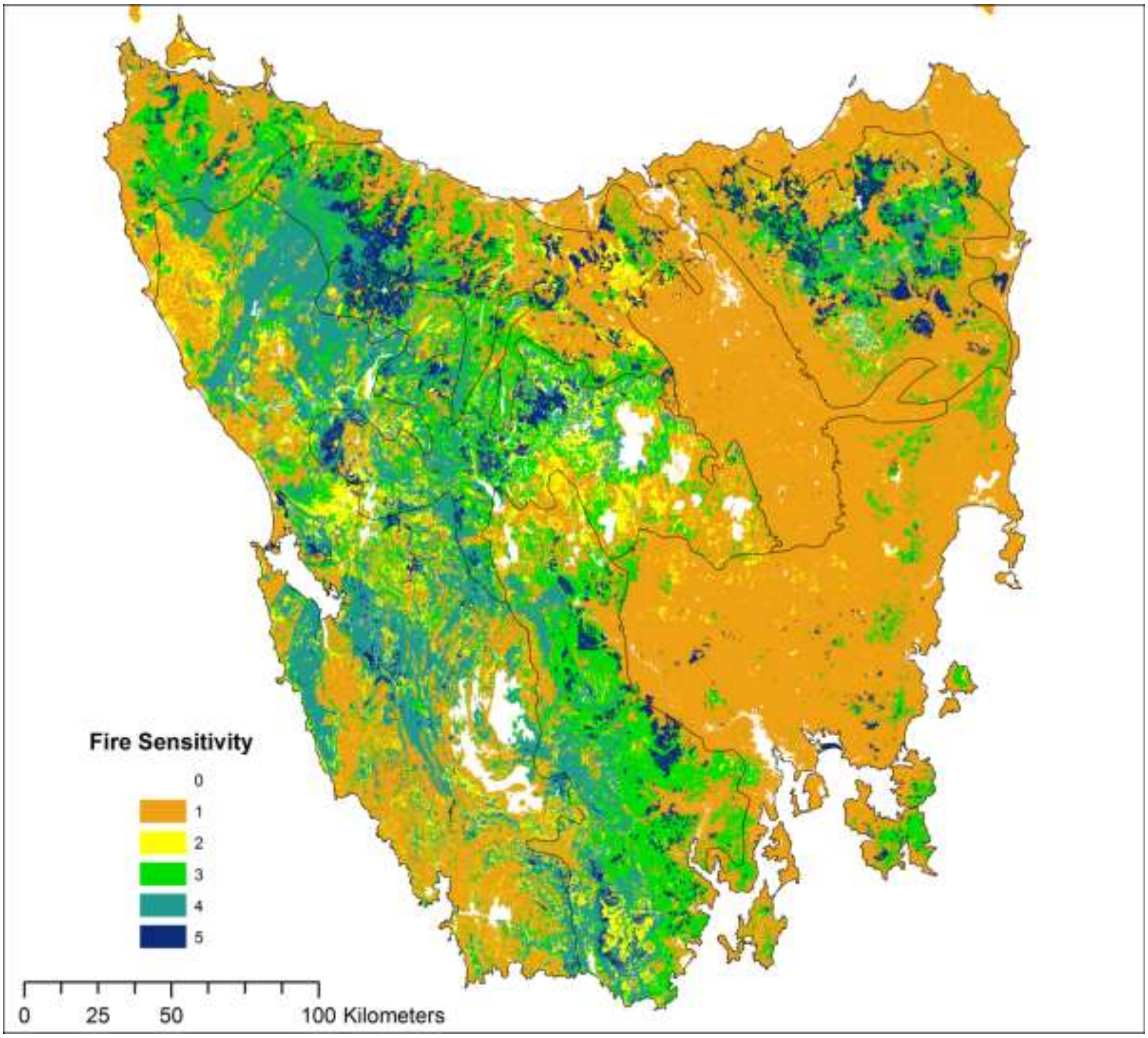

Figure 3 Fire sensitivity of vegetation types used to develop the Fire Refugia Index.

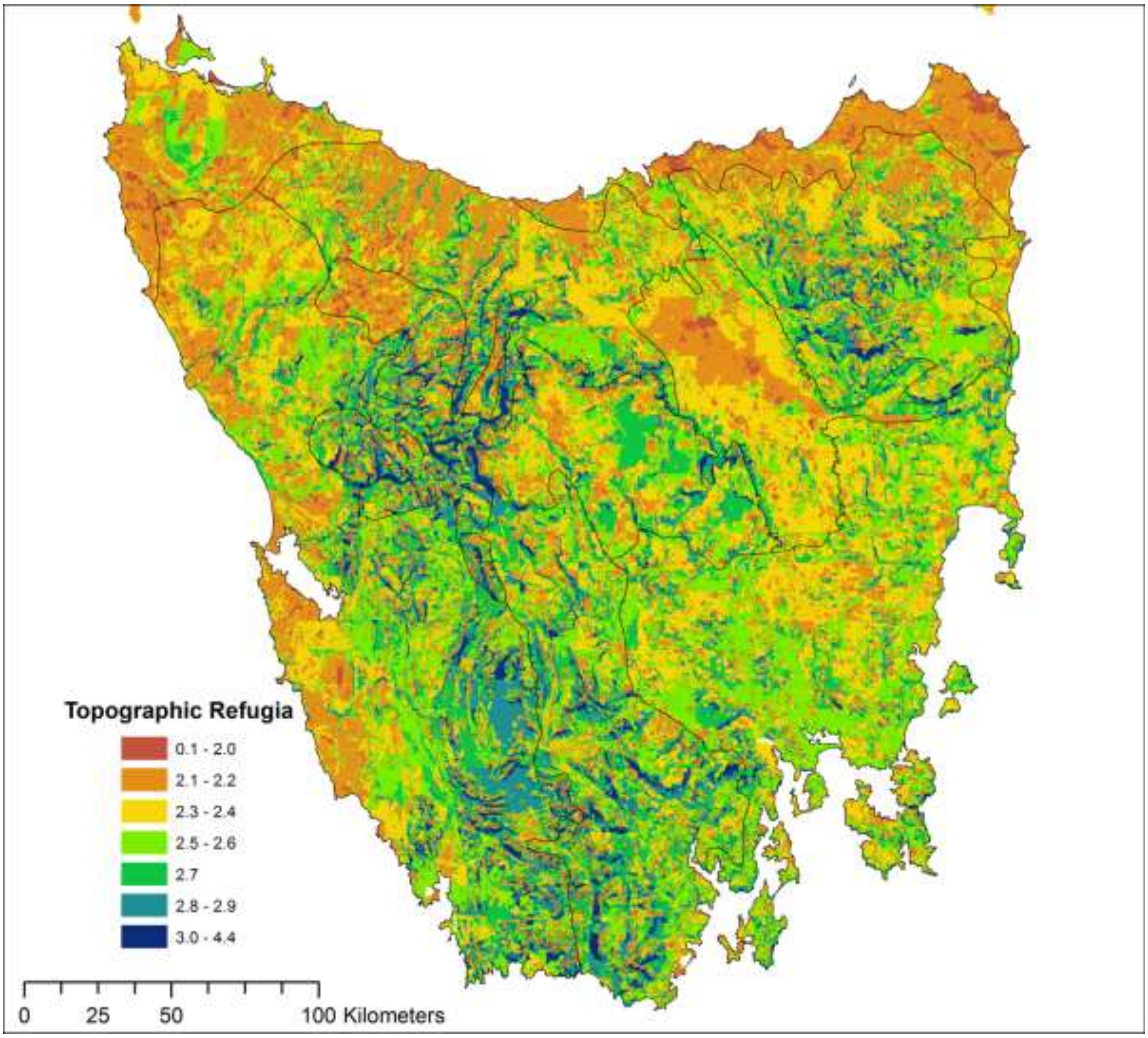

Figure 4 Topographic fire protection index derived from Tasdem 25 (ILS, DPIPWE).

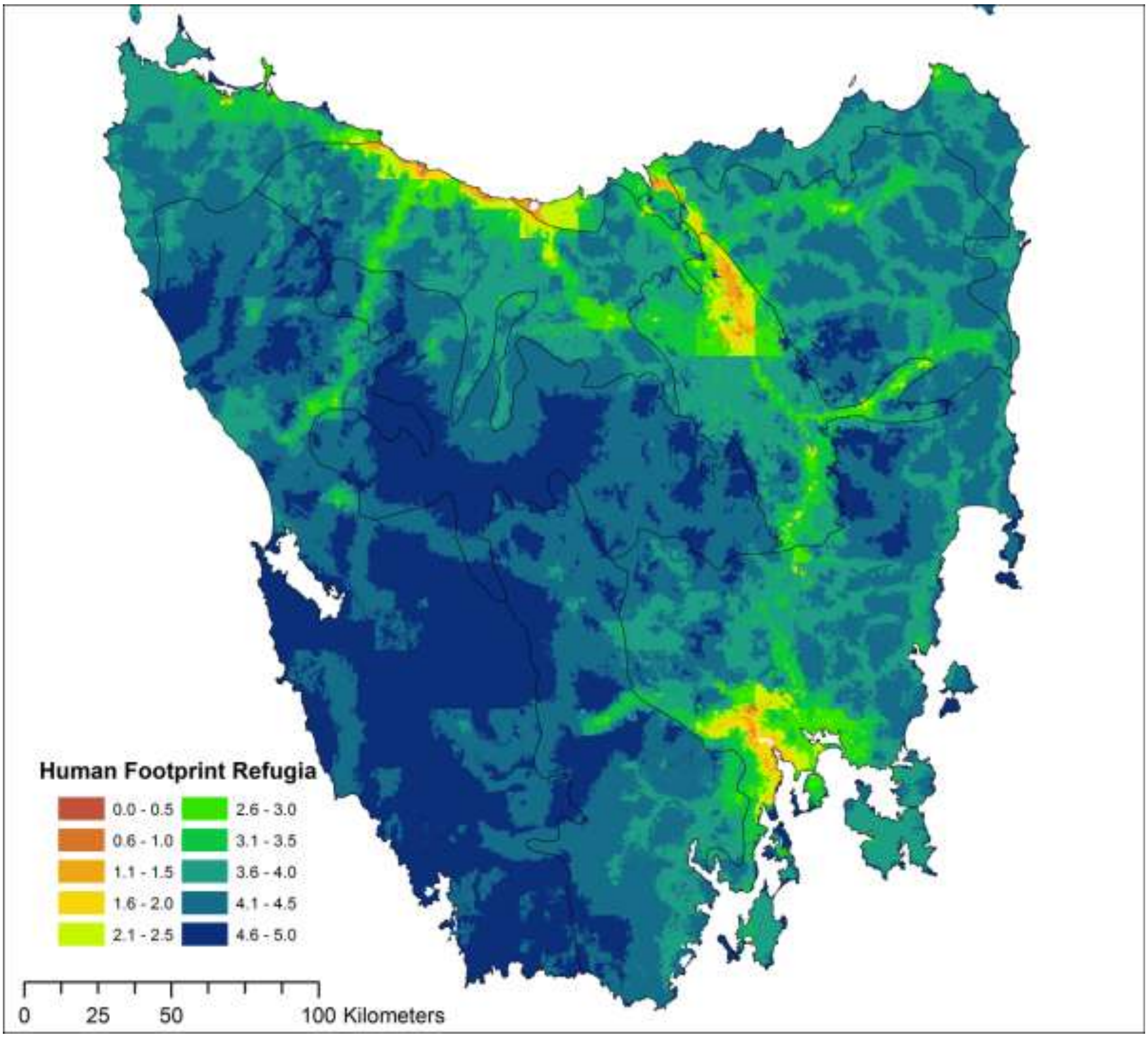

Figure 5 Human footprint (ignition) index, indicating probability of human-origin ignition sources. (Sanderson *et al.* 2003)

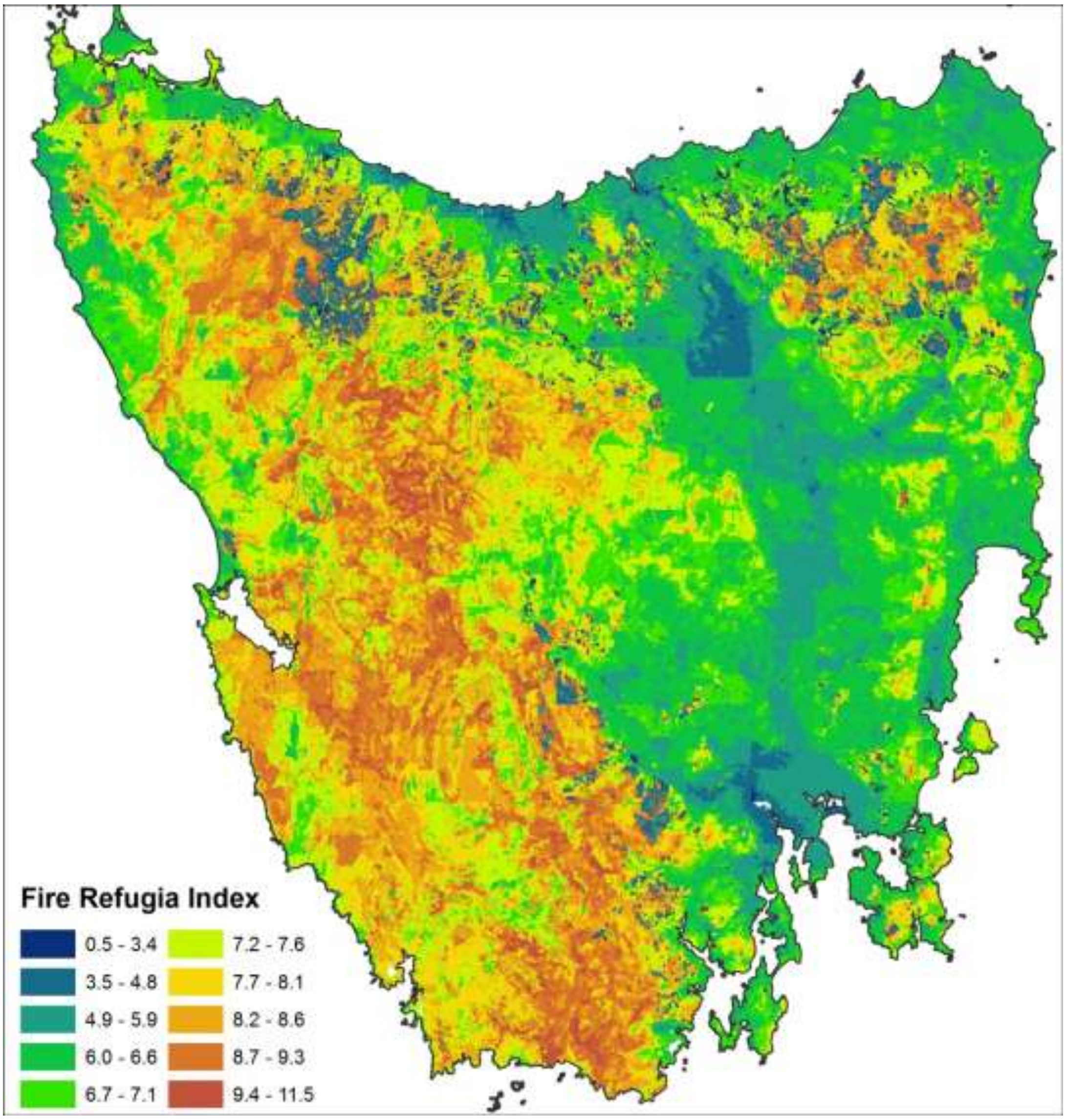

Figure 6 Combined fire refugia index.

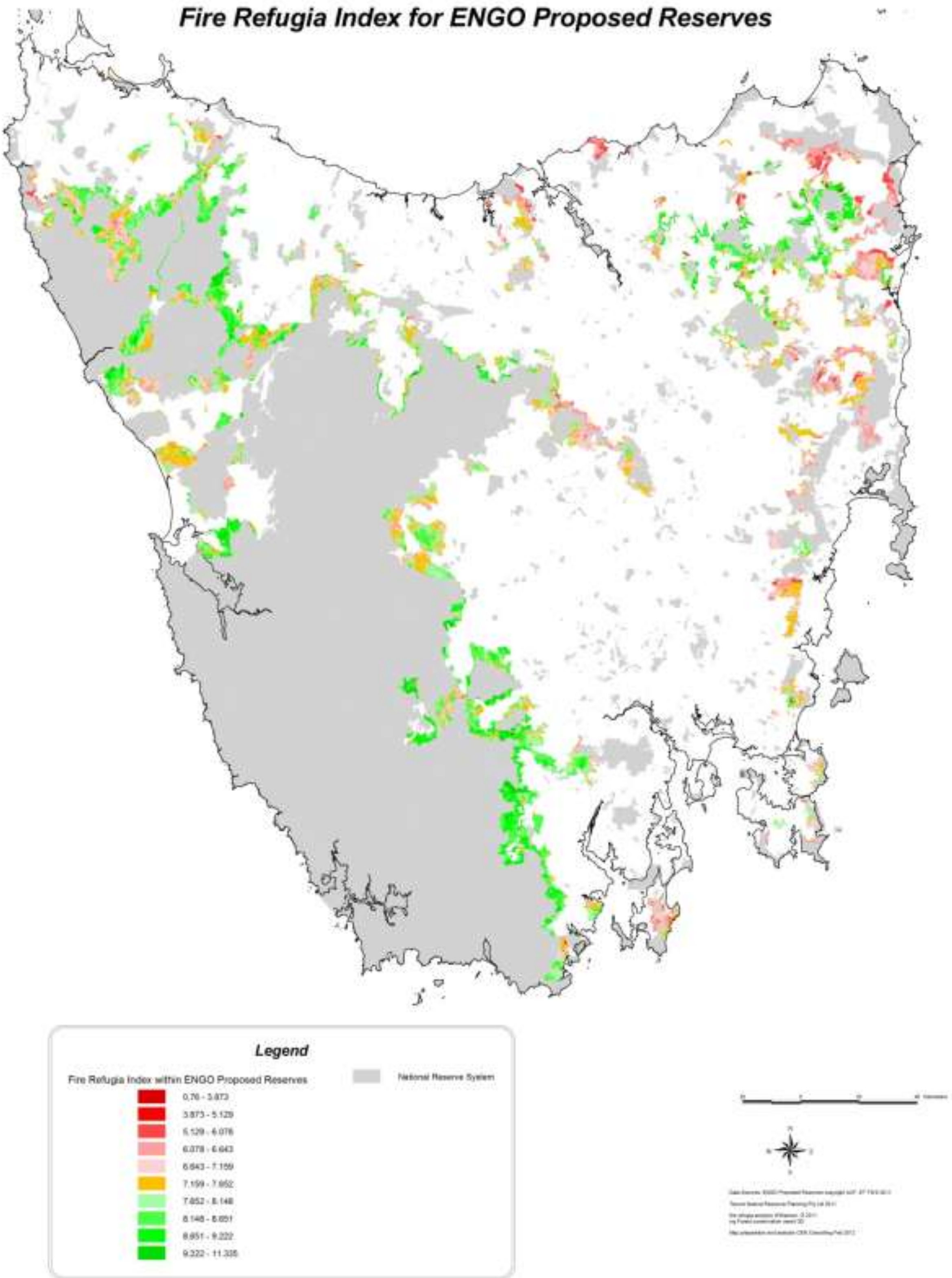

Figure 7 Fire refugia area index of proposed reserves.

Main Findings

In total, of the area of the state comprised of HFR forest vegetation (1,146,461 ha), 804,654 ha (70.2%) is already protected by existing, informal or private reserves, an additional 156,814 ha (13.7%) will be protected by the proposed ENGO reserves, while 184,922 ha (16.1%) remains unprotected (Table 1). The concentration of fire sensitive vegetation, protective topography and remoteness from human populations in the west of the state produces the highest high fire refugia (HFR) values, and this area is already protected by a number of large reserves, including the World Heritage Area, the Franklin-Gordon Wild Rivers National Park, and the Cradle Mountain-Lake Saint Clair National Park, hence the relatively high degree of protection already offered to HFR vegetation, particularly in Tasmania's West and Central Highlands. In contrast, populated, highly modified areas such as the Midlands contain little vegetation of fire refugia importance.

Bioregion	Total	Existing (ha)	Proposed (ha)	Unprotected (ha)	Existing (%)	Proposed (%)	Unprotected (%)
Ben Lomond	93526	26445	31139	35942	28.3%	33.3%	38.4%
Flinders	1284	136	850	298	10.6%	66.2%	23.2%
King	40188	10527	4932	24659	26.2%	12.3%	61.4%
Central Highlands	185990	165462	9132	11396	89.0%	4.9%	6.1%
Northern Midlands	1142	198	119	825	17.3%	10.4%	72.2%
Northern Slopes	101500	44688	14660	42152	44.0%	14.4%	41.5%
South East	8510	2806	995	4709	33.0%	11.7%	55.3%
Southern Ranges	273098	165666	53208	54223	60.7%	19.5%	19.9%
West	441223	388726	41779	10718	88.1%	9.5%	2.4%
Total	**1146461**	**804654**	**156814**	**184922**	**70.2%**	**13.7%**	**16.1%**

Table 1. High fire refugia status forest vegetation in Tasmanian bioregions and tenure classes.

The IBRA bioregion with the largest area of HFR vegetation was the Tasmanian West, with 441,223 ha in total. The vast majority of this vegetation (88.1%) is already contained within reserves, and the proposed reserves add an additional 41,779 ha in this bioregion. Most of the 273,089 ha of HFR vegetation in the Tasmanian Southern Ranges is already protected in existing reserves (60.7 %), and the proposed reserves will add an additional 53,208 ha. The

Tasmanian Central Highlands also have significant areas of HFR vegetation, with 185,990 ha, and again most (89%) is already protected by existing reserves, with the proposed reserves adding an additional 386 ha. Other bioregions have relatively minor areas classified as HRF vegetation.

A list of the top 15 reserves ranked by Fire Refugia Area Index, the index that integrates weighted proportional area with under different fire refugia status, is shown in table 2. A number of very small reserves containing minor pockets of high fire refugia status (HFR) vegetation were excluded, and this list contains only those reserves with total HFR forest area over 10 hectares. A map of reserve fire refugia area index scores is presented in figure 7. A list of the top 15 reserves by the total area of high fire refugia status vegetation is also included (Table 3). Reserve 219, on the northern slopes, has the highest fire refugia value in terms of the combined Fire Refugia Area Index score (299.7/300), and the area of this vegetation (710 ha), while reserve 25 in the southern ranges, an extremely large reserve, has the highest total area of HFR vegetation protected (35,827 ha).

Reserve Number	Fire Refugia Area Index	Area of High Fire Refugia Status (ha)
16	300	12.8088
38	300	23.9961
83	300	49.69487
175	300	66.423
202	300	48.87374
210	300	17.24928
222	300	29.9059
246	300	10.05753
31	299.9	66.7184
219	299.7	710.3881
221	299.47	321.8878
160	299.43	25.4447
241	298.9	44.27721
24	298.5	75.89254
28	296.95	13.09571

Table 2. Top 15 reserves by Fire Refugia Area Index, excluding those reserves with small (<10 ha) absolute areas of high fire refugia status.

Reserve Number	Fire Refugia Area Index	Area of High Fire Refugia Status (ha)
25	224.18	35827.09
252	173.69	19136.21
198	200.18	16633.53
258	146.4	8633.615
208	198.27	7822.03
33	192.83	6755.382
52	244.44	5325.725
111	152.71	3388.401
149	173.95	3185.914
35	263.79	2469.492
197	170.28	2404.034
30	281.79	2007.097
19	268.52	1921.417
125	208.34	1779.682
26	286.55	1722.632

Table 3. Top 15 reserves by absolute area of high fire refugia status.

Conclusions and management implications

The proposed reserves will contribute non-trivially to the protection of ecosystems of high fire refugia value, and associated high-value restricted vegetation communities, by protecting an additional 13.7% of such areas in the state. A potential advantage of establishing formal reserves in the proposed areas is the potential to restrict vehicular access by closing existing forestry roads. Proximity to road is an important driver of anthropogenic wildfire ignitions (Syphard *et al*. 2007), and the status of moderate fire refugia index areas would be enhanced, and the high fire refugia index areas maintained through such road closures. Ability to limit ignition in fire-sensitive areas is limited, however, where the proposed reserves border on agricultural and active forestry land and there is the potential for fire spread across boundaries.

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