Flora Technical Note No. 13:

Threatened Flora Habitat Suitability Models (HSM)

FPA
FOREST PRACTICES AUTHORITY

The Flora Technical Note Series *provides information for Forest Practices Officers on flora management in production forests. These technical notes are advisory guidelines and should be read in conjunction with the requirements of the* Forest Practices Code. *This technical note may provide useful information for other non-forestry industries but has been developed for use in the forest practices system and therefore data may reflect nuances in the forest practices system.*

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1. Introduction

Tasmania has over 490 threatened flora species with approximately two-thirds potentially occurring in areas subject to forest practices. These threatened flora species are often characterised by their small population sizes, restricted ranges and/or cryptic nature. These characteristics mean there is limited information on the distribution of many of these threatened species and, in turn, a lack of information on where suitable habitat for these species can be found.

Under the Tasmanian forest practices system, forest planners are required to consider both the known sites of threatened species (i.e. sites recorded on available databases, which correspond to a georeferenced location), and potential habitat for threatened species. Under the forest practices system, potential habitat is defined as all habitat types within the potential range of a species that are likely to support that species in the short and/or long term (Forest Practices Authority, 2008). Potential habitat is determined from published and unpublished scientific literature and/or expert opinion and is agreed by DPIPWE in consultation with species specialists (Forest Practices Authority, 2012).

With limited information on the distribution of many threatened flora species, and by extension limited information on their suitable habitat, it is difficult to prioritise and manage potential habitat for all threatened flora species. Not knowing where suitable habitat is located may result in both over and underestimation of the extent of potential habitat, and therefore inadvertent loss of important habitat or ineffective conservation management.

To fill this knowledge gap, the FPA developed Threatened Flora Habitat Suitability Models for 46 of Tasmania's most vulnerable and at risk threatened plant species (Table 1). The Threatened Flora Habitat Suitability Models are a 'heat map' (defined as a representation of data in the form of a map in which data values are represented as colours) that indicates the approximate relative likelihood that a given location will contain suitable habitat for a species.

This technical note provides a brief overview of the Threatened Flora Habitat Suitability Models and explains how the models should be used to aid on-ground flora surveys during the development of Forest Practices Plans (FPPs).

Table 1. List of threatened flora species with habitat suitability models

Species	Common Name	Status (Tasmania)	Status (C'wealth)	Environmental Variable with Most Influence on Model
*Allocasuarina duncanii**	Conical sheoak	Rare	-	Annual Mean Radiation 27%
Banksia serrata	Saw banksia	Rare	-	Geology 68%

Species	Common Name	Status (Tasmania)	Status (C'wealth)	Environmental Variable with Most Influence on Model
*Caladenia anthracina**	Blacktip spider-orchid	Endangered	Critically Endangered	Temperature Seasonality 50%
*Caladenia campbellii**	Thickstem fairy fingers	Endangered	Critically Endangered	Geology 65%
*Caladenia caudata**	Tailed spider-orchid	Vulnerable	Vulnerable	Elevation 23%
Caladenia congesta	Blacktongue finger orchid	Endangered	-	TasVeg 38%
*Caladenia dienema**	Windswept spider-orchid	Endangered	Endangered	Temperature Seasonality 32%
Caladenia filamentosa	Daddy longlegs	Rare	-	TasVeg 46%
Caladenia patersonii	Patersons spider-orchid	Vulnerable	-	TasVeg 34%
Callitris oblonga subsp. *oblonga*	South Esk pine	Vulnerable	Endangered	Isothermality 41%
Cyathea cunninghamii	Slender treefern	Endangered	-	Radiation Seasonality 28%
Cyathea x marcescens	Skirted treefern	Endangered	-	Geology 40%
*Epacris apsleyensis**	Aspley heath	Endangered	Endangered	Radiation Seasonality 84%
*Epacris curtisiae**	Northwest heath	Rare	-	TasVeg 46%
*Epacris glabella**	Smooth heath	Endangered	Endangered	Geology 67%
*Epacris limbata**	Bordered heath	Endangered	Critically Endangered	Radiation Seasonality 42%
Epacris virgata (Beaconsfield)	Pretty heath	Vulnerable	Endangered	Geology 81%
Hibbertia calycina	Lesser guineaflower	Vulnerable	-	Geology 70%
Hibbertia virgata	Twiggy guineaflower	Vulnerable	-	Annual Mean Temperature 29%
*Hypolepis distans***	Scrambling groundfern	Endangered	Endangered	Precipitation Seasonality 32%
Leucopogon virgatus var. *brevifolius*	Shortleaf beardheath	Rare	-	TasVeg 56%
*Micrantheum serpentinum**	Western tridentbush	Rare	-	Geology 87%
*Olearia hookeri**	Crimsontip daisybush	Rare	-	Geology 42%

Species	Common Name	Status (Tasmania)	Status (C'wealth)	Environmental Variable with Most Influence on Model
Persoonia muelleri subsp. *angustifolia**	Narrowleaf geebung	Rare	-	Geology 30%
Pneumatopteris pennigera	Lime fern	Endangered	-	Precipitation Seasonality 43%
Polyscias sp. Douglas-Denison	Ferny panax	Endangered	-	Radiation Seasonality 58%
Pomaderris pilifera subsp. *talpicutica**	Moleskin dogwood	Endangered	Vulnerable	Geology 55%
*Prasophyllum stellatum**	Ben Lomond leek-orchid	Endangered	Critically Endangered	Geology 29%
Pterostylis grandiflora	Superb greenhood	Rare	-	Radiation Seasonality 55%
Pterostylis squamata	Ruddy greenhood	Vulnerable	-	Radiation Seasonality 37%
Pultenaea humilis	Dwarf bushpea	Vulnerable	-	TasVeg 72%
Pultenaea mollis	Soft bushpea	Vulnerable	-	Geology 29%
Pultenaea prostrata	Silky bushpea	Vulnerable	-	Annual Precipitation 36%
Pultenaea sericea	Chaffy bushpea	Vulnerable	-	Geology 46%
Rhytidosporum inconspicuum	Alpine appleberry	Endangered	-	TasVeg 52%
*Spyridium obcordatum**	Creeping spyridium	Vulnerable	Vulnerable	Precipitation Seasonality 20%
Stackhousia subterranea	Grassland candles	Endangered	-	TasVeg 13%
*Stenanthemum pimeleoides**	Propeller plant	Vulnerable	Vulnerable	Isothermality 49%
Tetratheca ciliata	Northern pinkbells	Rare	-	TasVeg 33%
*Tetratheca gunnii**	Shy pinkbells	Endangered	Critically Endangered	Geology 88%
Thelymitra antennifera	Rabbit ears	Endangered	-	TasVeg 75%
Thelymitra atronitida	Blackhood sun-orchid	Endangered	-	TasVeg 22%
Thelymitra malvina	Mauvetuft sun-orchid	Endangered	-	Elevation 24%
Thryptomene micrantha	Ribbed heathmyrtle	Vulnerable	-	Radiation Seasonality 44%

Species	Common Name	Status (Tasmania)	Status (C'wealth)	Environmental Variable with Most Influence on Model
Xanthorrhoea species (X. arenaria; X. bracteata*)*	Sand grasstree; shiny grass tree	Vulnerable; vulnerable	Vulnerable; Endangered	Annual Mean Temperature 27%
* denotes endemic to Tasmania ** within Australia, only occurs in Tasmania				

2. Model development

Location

The habitat suitability models have been prepared for the entirety of Tasmania; including Bass Strait Islands and other off-shore islands (e.g. Bruny Island, Maria Island). As part of the modelling, the state was divided into 100 m^2 cells: this value was selected as it is a commonly used unit when undertaking forest planning.

Species selection

46 of Tasmania's most vulnerable and information-poor threatened flora species (Table 1) were selected to be modelled through a threatened flora prioritisation process undertaken during the development of the FPA's Threatened Plant Adviser (Forest Practices Authority, 2020). During this process all of Tasmania's threatened flora were placed into groups based on the risk of forestry operations to the disturbance or loss of each species and available ecological knowledge. The groups ranged from very low-risk (species that did not occur in areas subject to forestry), to moderate- and high-risk species. A total of 115 species were assessed to occur in the high-risk group. The 46 species modelled were selected from the high-risk group as they were considered to be both at high-risk from forestry operations as well as having limited information on where their suitable habitat was located. Most of the species included in the model are listed in the high conservation status of endangered or vulnerable under the Tasmanian *Threatened Species Protection Act 1995*.

Known records for the 46 species were sourced from the Natural Values Atlas. Any species records with position accuracies greater than 100 m were removed to ensure consistency with the 100 m^2 grid cells used in the model. In addition, all datasets were reviewed by species specialists to remove any records known to be inaccurate.

Environmental variable selection

Environmental variables for use in the model were determined using expert opinion, as the variables most likely to influence the distribution of flora in Tasmania, for which spatial data was available (Table 2).

Table 2.

Environmental variable	Description	Variable Type	Source
TASVEG 3.0	TASVEG is a Tasmania-wide vegetation map produced by the Tasmanian Vegetation Monitoring and Mapping Program.	Categorical	ListMap
Geology of Tasmania	Geology and structure data derived from Digital Geological Atlas printed map series and digital geology data where available. Geological units and boundaries have been generalised.	Categorical	ListMap
Digital Elevation Model (DEM)	The Tasmania Digital Elevation Model (DEM) is a regular grid of ground level elevation values across the extent of the land area of Tasmania and most of the associated off shore Tasmanian islands.	Continuous	ListMap
Bioclim_1 Annual Mean Temperature	The mean of all the weekly mean temperatures. Each weekly mean temperature is the mean of the weekly maximum and minimum temperatures over the whole year (Xu and Hutchinson, 2010). Units: degrees celsius	Continuous	Climate Futures
Bioclim_3 Isothermality	A quantification of how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations (O'Donnell and Ignizio, 2012). Units: percentage	Continuous	Climate Futures
Bioclim_4 Temperature Seasonality	The amount of temperature variation over a given year (or averaged years) based on the standard deviation (variation) of monthly temperature averages (O'Donnell and Ignizio, 2012). Units: degrees celsius	Continuous	Climate Futures
Bioclim_7 Temperature Annual Range	The difference between the Max Temperature of Warmest Period and the Min Temperature of Coldest Period (Xu and Hutchinson, 2010). Units: degrees celsius	Continuous	Climate Futures
Bioclim_12 Annual Precipitation	The sum of all total monthly precipitation values (O'Donnell and Ignizio, 2012). Units: millimeters	Continuous	Climate Futures
Bioclim_15 Precipitation Seasonality	A measure of the variation in monthly precipitation totals over the course of the year. This index is the ratio of the standard deviation of the monthly total precipitation to the mean monthly total precipitation (also known as the coefficient of variation) and is expressed as a percentage (O'Donnell and Ignizio, 2012). Units: percentage	Continuous	Climate Futures
Bioclim_20 Annual Mean Radiation	The mean over the whole year of all the weekly solar radiation estimates Xu and Hutchinson, 2010). Units: watt per square metre	Continuous	Climate Futures
Bioclim_23 Radiation Seasonality	The amount of solar radiation variation over a given year (or averaged years) based on the standard deviation of monthly solar radiation averages. Units: percentage	Continuous	Climate Futures

Modelling methodology

Species distribution models (SDM) are useful tools for estimating suitable habitat for species, using associations between environmental variables and known presence records of species across locations and habitats of interest (Araujo and Peterson, 2012). Maximum entropy modelling (MaxEnt),

a software program which estimates the relationship between species records at sites and the environmental and spatial characteristics of those sites (Elith, et al. 2011), was used to prepare the SDMs that act as proxy habitat suitability models. The software estimates the relationship between known flora records and environmental variables across each 100 m^2 grid cell with the resultant model output a relative habitat suitability measure for each cell and for each of the 46 species. Table 1 outlines which environmental variable had the greatest influence on each species and were therefore the key determinants of their distribution.

3. Using the habitat suitability models

How to access the HSM on the BVD

The 46 models are available via the Biodiversity Values Database (BVD) on the FPA website. Species with models are indicated on the BVD on the 'Threatened Flora Survey Notes' table in the column named 'Habitat Suitability Model'. To view a model on the BVD map there are two options; you can either click the species row on the 'Threatened Flora Survey Notes' table or you can search for the species from the BVD layers. To do this click the 'Search' icon 🔍 on the right of the BVD map and type in the species scientific or common name and then click the box icon to turn on the model in the BVD.

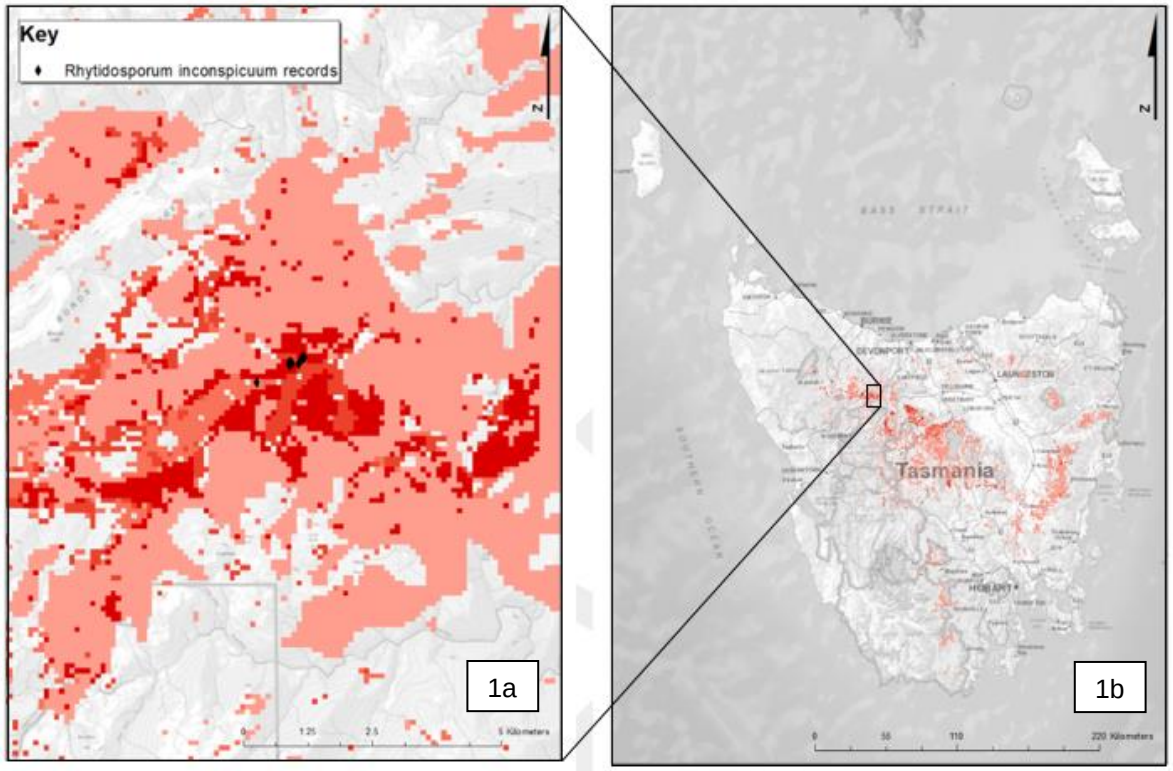
All models are also available as files, for use in a GIS, from the FPA by request.

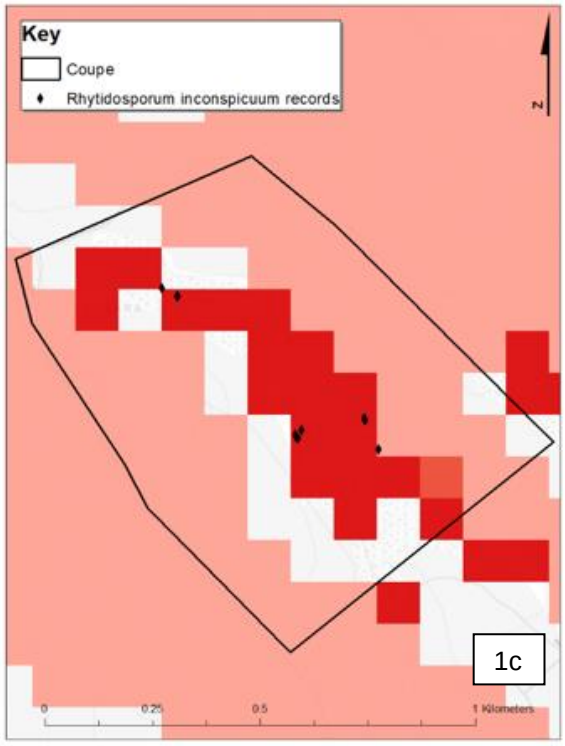
When and how to use the HSM

The threatened flora habitat suitability models are high-resolution tools that forest planners can employ when deciding where to target flora surveys. If you have a known site within 2km; then run the Threatened Plant Adviser to see if you need to conduct a survey (as per recommendations); then use the appropriate model to determine where you need to survey.

As an example, Figure 1b shows the state-wide model for the alpine appleberry (*Rhytidosporum inconspicuum*), and a close up of the model in Middlesex, in the Kentish municipality (Figure 1a), showing the continuum of shades used differentiate habitat of varying suitability.

For all models, each 100 m^2 grid cell is assigned one of five habitat suitability ratings from very low suitability to very high suitability (see Figure 1d). Areas of moderate, high and very high suitability that fall within an operational area indicate the areas of highest priority for surveying for the target species. The model is based on spatial data and it is accepted that more accurate site-specific information gathered from field surveys may alter the habitat suitability rating. Users should consider the Key Habitat Determinant from Table 1 when deciding whether to conduct a species survey. These models can be used in combination with the information from a BVD report such as known records (♦ on figure 1a) and the Habitat descriptions and survey notes for flora species (Forest Practices Authority, 2016). In combination, these resources allow forest planners to target priority areas for species when undertaking surveys.





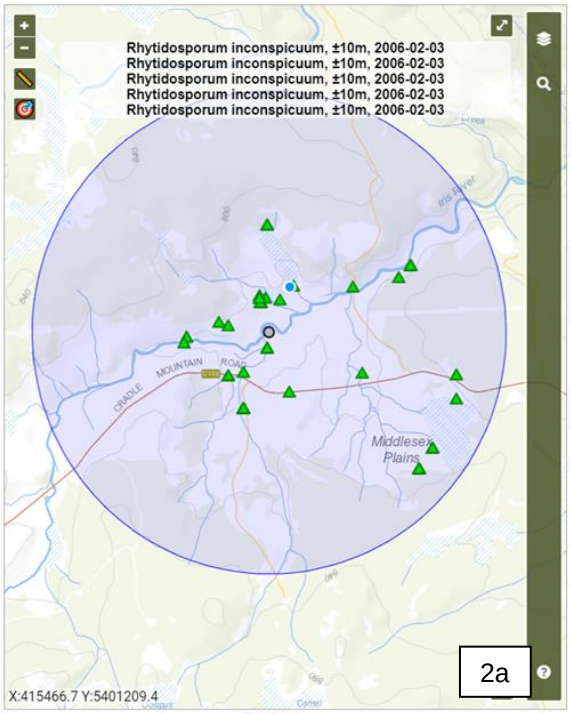
Suitability Rating	Suitability Range (%)
Very High Suitability	80-100
High Suitability	60-80
Moderate Suitability	40-60
Low Suitability	20-40
Very Low Suitability	0-20

1d

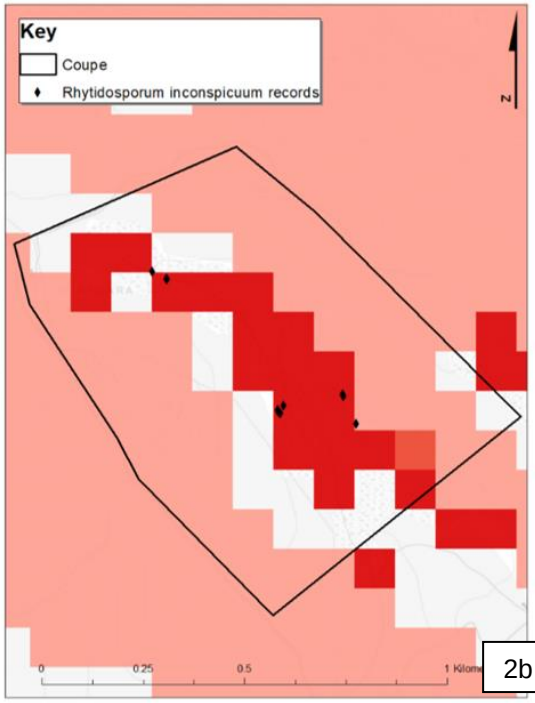
Figure 1. Habitat suitability model for *Rhytidosporum inconspicuum* in the Bonds Range and wider Tasmania.

Worked example

A forest planner is preparing a forest practices plan (FPP) in the Middlesex area, with the proposed operational area located just north of Cradle Mountain Road. The planner is required to enter the coordinates for the operational area into the BVD, which then produces a map (figure 2a.) and list of threatened flora species within 2 km of the entered coordinates. One of the species generated by this process (Figure 2c) is *Rhytidosporum inconspicuum* (alpine appleberry), a threatened flora species. The BVD indicates that there is a habitat suitability model available for *R. inconspicuum* and as a result the forest planner can access this habitat suitability model as a layer on the BVD, or download a copy for use in a GIS. The forest planner can then overlay the model onto their GIS planning systems and see which areas in the operational area potentially support suitable habitat for the species including the habitat suitability rating (e.g. low, moderate, high) (Figure 2b). For areas modelled to be of moderate, high or very high suitability, the forest planner can use the model in combination with information in the threatened habitat description and survey guidelines (Figure 2d), to determine the priority areas for ground surveys to potentially maximise efficiency and likelihood of locating potential habitat or sites for the species of interest.



2a



2b

Species name	Common name	Reported Position accuracy (m)	X	Y	Distance (m)	Obs. type	Obs. date	Date accuracy	Obs. state	NVA id
Rhytidosporum inconspicuum	alpine appleberry	10	415523	5401198	424	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415499	5401202	417	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415290	5401095	273	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415251	5401060	247	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415252	5401063	250	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415240	5401097	286	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415482	5401204	412	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415490	5401199	410	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415485	5401202	411	Sighting	2006-02-03	Day	Present	NVA
Rhytidosporum inconspicuum	alpine appleberry	10	415240	5401095	284	Sighting	2006-02-03	Day	Present	NVA

2c

Species name	Common name	Life form	Status TSPA, EPBCA	Habitat description	Survey guidelines	Survey skill level
Rhytidosporum inconspicuum	alpine appleberry	shrub	e, -	Rhytidosporum inconspicuum occurs in open grassy heath at several montane sites in the Central Highlands and in wetter grassy, sedgy or heathy areas, sometimes in eucalypt woodland, at lower altitudes in the Eastern Tiers. Rhytidosporum inconspicuum has been recorded from 10-1240 m a.s.l.	This prostrate and spreading undershrub is difficult to find, but is most easily detected and identifiable when flowering or fruiting, in late October to early December, and January to early February, respectively in lowland and montane areas.	3

2d

4. Limitations

- The maps are models. Like any model they are a representation based on the best available information. The models allow forest planners to target surveys in areas of suitable habitat but do not guarantee that specimens will be found in those areas as the models do not take into account various factors such as barriers to dispersal or biotic interactions (e.g. competition, predation etc.).
- The models for different species cannot be compared to each other as all data is relative and for each model the suitability of each cell is relative to the other cells.

5. Review and Adaptive Management

- The models have been endorsed for an initial 12-month trial period to test their usefulness and efficacy.
- The models will then be reviewed annually with new data added when there is an influential change in the data, or new records that are >10% of the original model numbers.

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Publication details

This technical note has been prepared by Angela Gardner, with the assistance of Anne Chuter and Mark Wapstra (EcoTas). It should be cited as:

Forest Practices Authority 2020, Threatened Flora Habitat Suitability Models, *Flora Technical Note No. 13.* Forest Practices Authority, Hobart.

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