natural resource planning

Two part process for spatial modeling of species habitat in the Regional Ecosystems Model

Rod Knight, November 2014

Natural Resource Planning's Regional Ecosystem Model is a comprehensive system for:

- Integrating spatial data on the distribution of the major components of biodiversity, and the factors affecting them;
- Analysing the relationships among the components of biodiversity and the environment; and
- Spatially identifying areas which have immediate or potential conservation concerns, and providing indicators of their relative importance, to inform approaches and priorities for management.

The REM was originally developed with funding from the Australian Government's Caring for Our Country program. It has since been applied in a variety of contexts, including forest management and certification, local government planning, property management, and as a decision support tool for ecological restoration and rehabilitation projects.

The REM is built on:

- A systematic, hierarchical model of biodiversity attributes (vegetation and priority species) and indicators of landscape scale ecological function (e.g. condition, patch size, connectivity). Attachment 1 shows the structure of the model.
- A spatial architecture designed to capture and analyse data on all components of the model at high resolution (0.1 ha).

A key factor in the REM having sufficient utility for its intended purposes is the ability to spatially model habitat of as many species of 'priority' flora and fauna as possible. Priority species in this context are those whose conservation needs may not be adequately met simply by managing native vegetation communities (a surrogate for species assemblages) or of the landscape generally. The priority species modeled in the REM are all listed threatened species in Tasmania, flora species identified as poorly reserved either Statewide or in some of their bioregions, and some non-listed fauna species considered to be of particular concern, priority or importance for other reasons (e.g. Eastern Quoll, Tasmanian Betting).

Detailed spatial habitat models exist for only some of the Tasmanian priority species. To address this limitation, a two part modeling process is used in the REM to ensure that all species are addressed:

- A generic model incorporating relatively few habitat variables to model habitat of all priority species from known locations in the Natural Values Atlas; and
- More detailed models developed for individual species using a broader range of habitat variables identified as having strong associations with the species concerned.

Both types of models are maintained on a continuous improvement basis. They are updated regularly to reflect changes in species data, understanding of species habitats, new models and also feedback from users of the modeled outputs.

Generic species models

The generic species models in the REM are based on each priority species being classified according to a small number of habitat variables that are contained within Natural Values Atlas data or the standard data captured by the REM (Table 1). Table 2 provides some examples of the range of generic species modeling rules. Figure 1 shows some examples of modeled species habitat generated using this method.

Table 1. Habitat attributes used in generic modeling process

Habitat attribute	**Description**
Record accuracy.	The minimum accuracy for an NVA record to be used for modeling the species. Tighter accuracy limits are used for species that tend to occur in fixed, localised situations (e.g. many threatened flora), with more relaxed limits used for species which occur generally around their locations or are relatively mobile.
Record distance	The maximum distance from an NVA record in which habitat can be attributed. As with record accuracy, model distances are tighter for localised and immobile species and more relaxed for species with more general distributions or higher mobility.
Year	The earliest year for an NVA record to be included in a species model. This variable is designed to account for species whose distributions are known or reported to have changed (e.g. Eastern Barred Bandicoot, Tasmanian Devil).
Riparian	Where species are known to have strong riparian associations, the modeling process restricts the attribution of habitat around records to the riparian zones around streams, waterbodies and wetlands. Note: where records of such species are not in riparian zones, a standard point based model based on the other habitat variables is applied.
Water	This habitat variable allows the habitat of certain species to be modeled in water (e.g. waterbodies and larger streams). It applies to species such as fish and crayfish.

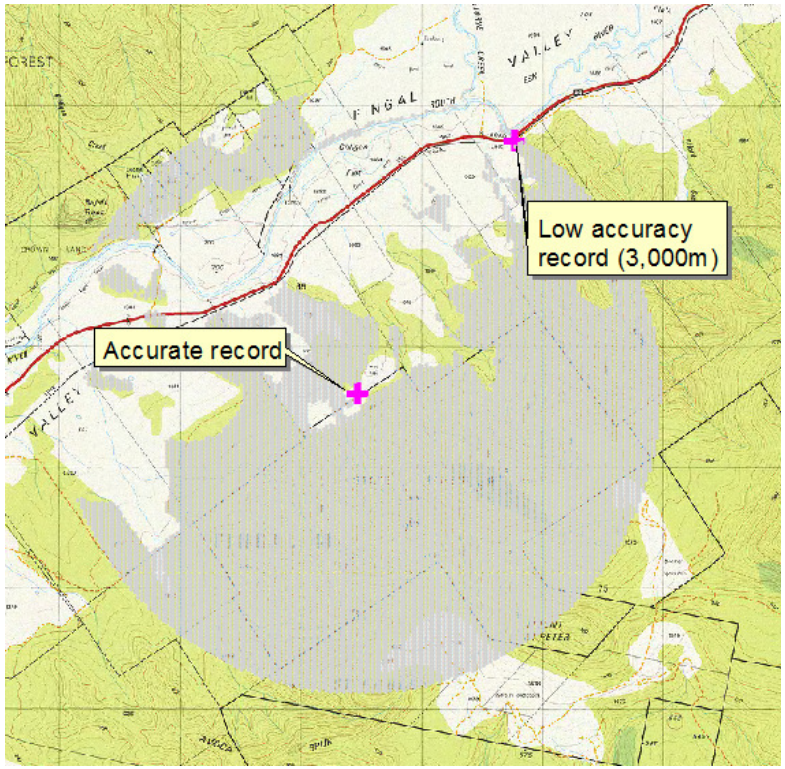
Habitat attribute	Description
Native	This habitat variable restricts the attribution of species habitat to areas of native vegetation only. The attribute is applied particularly to mobile fauna species with large proportions of their recorded locations from road kill. The model attempts to capture native vegetation which may be used for denning and shelter (and is usually accompanied by a larger value for the record distance variable).
Plantation	This habitat variable relaxes the modeling of habitat so that it can be attributed in plantations. Application of the variable is currently restricted to the zones around raptor nests, which may be sensitive to disturbance.
Bioregions	The habitat variable contains a list of bioregions in which flora species are identified as poorly reserved (<2 locations in reserves in the bioregion). The modeling process restricts the attribution of habitat to only those bioregions in the list.

Table 2. Examples of generic species modeling rules

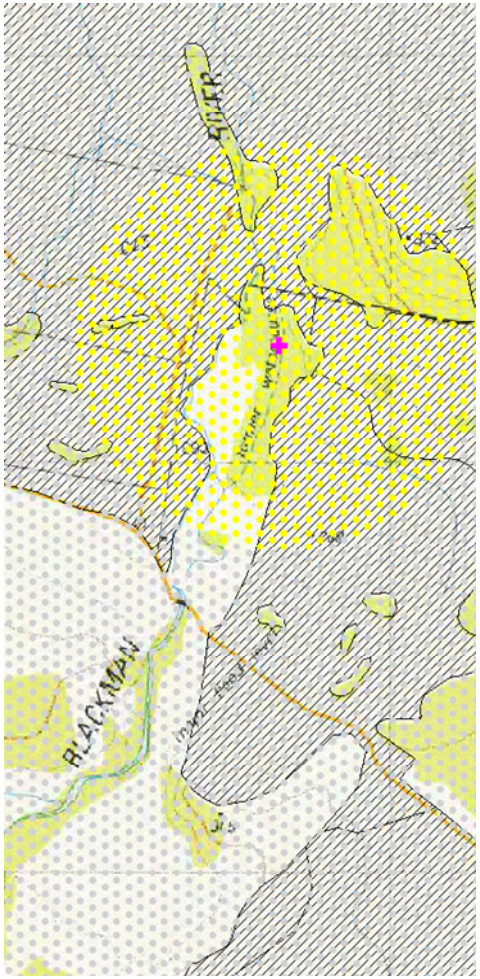
Species	Accuracy	Distance	Year (earliest)	Riparian	Plantation	Water	Native only	IBRA regions	Notes
Acacia axillaris	200	500	0	Y					Models riparian zones within 500m of NVA record
Aquila audax subsp. *fleayi*	200	500	0		Y				Models 500m around known nest sites, including in plantations
Caladenia anthracina	200	100	0						Models everything within 100m or record
Caladenia atrata	200	100	0					FL;NS;	Non-threatened species, poorly reserved in Flinders and Northern Slopes bioregions.
Perameles gunnii	500	2000	1980				Y		Models native vegetation within 2,000m of post-1980 records
Prototroctes maraena	200	500	0	Y		Y			Models riparian zones and water within 500m of records
Sarcophilus harrisii (post 2005)	200	2000	2005				Y		Model native vegetation within 2,000m of post-2005 records

Figure 1. Example of generic species habitat model outputs

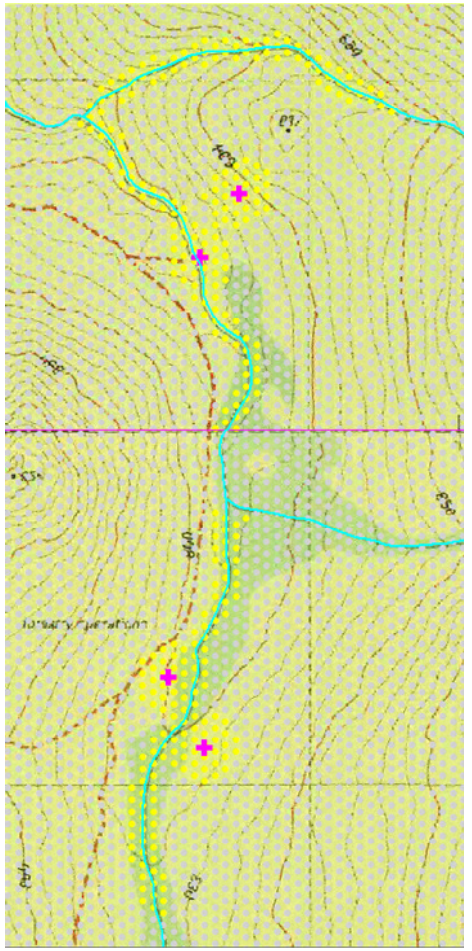
Eastern Quoll (native veg. within 2.5 km of 500m accuracy records)



Wedgie – nests



Acacia axillaris



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Detailed species habitat models

The focus for developing detailed spatial habitat models is those species less likely to be accurately modeled from known location records. It is particularly important for a number of fauna species. Detailed species habitat models are developed for the REM using an expert-based rules system in which the characteristics of each species are described from current knowledge and available data, which are in turn converted to GIS-based rules to achieve spatial outputs.

The current basis for both the list of species to be modeled and, as far as possible, the characteristics of the model to be produced, is descriptions of species range, habitat and significant habitat developed by the Forest Practices Authority[1]. The species being considered in that process have been described in terms of their:

- core range;
- potential range;
- known range;
- potential habitat;
- significant habitat; and
- other habitat definitions used in management.

The process of developing each detailed species model involves reviewing the standard FPA descriptors and other relevant information (e.g. other models, communications with researchers). Some species models can be developed relatively simply from this information.

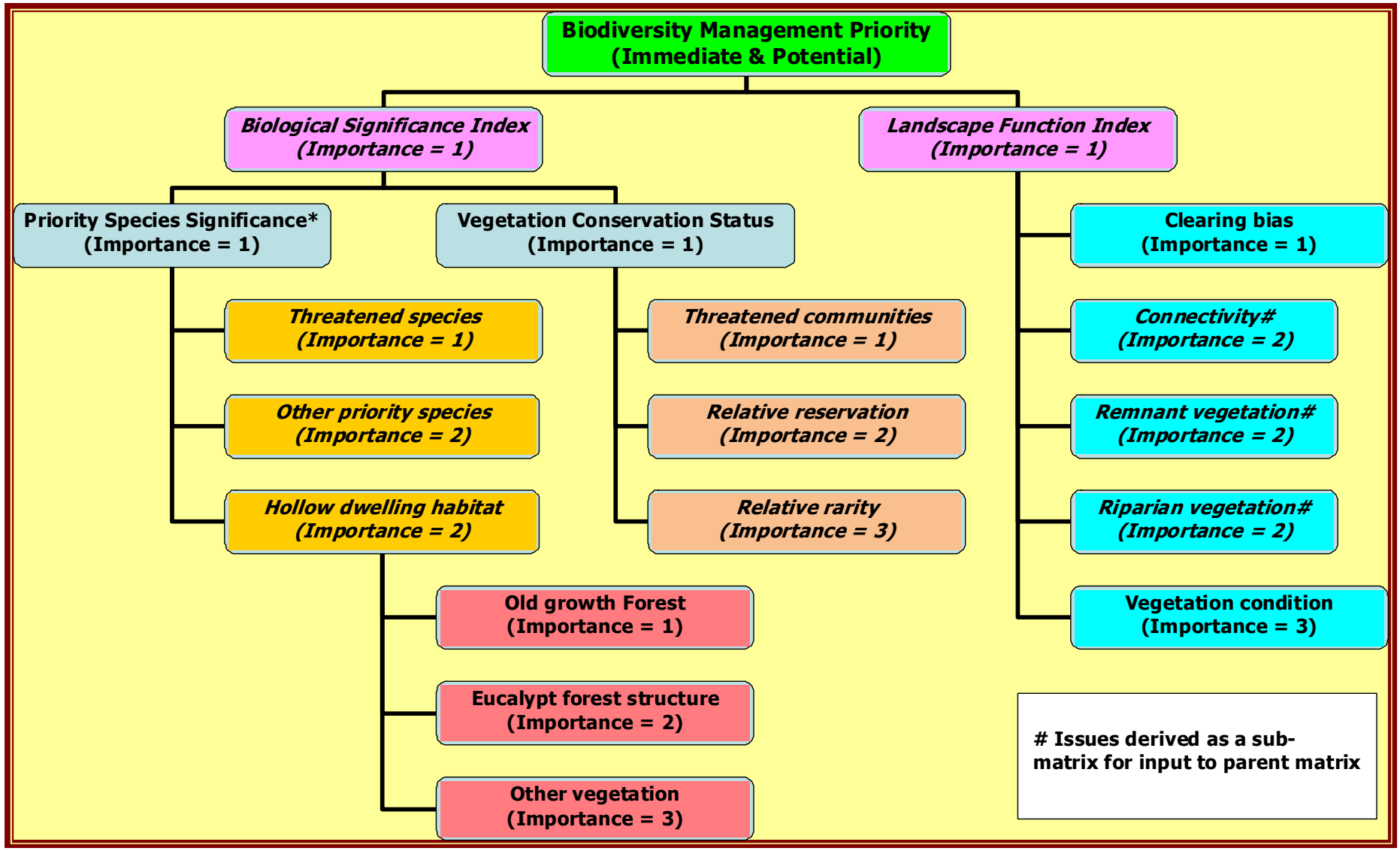
For other species the modeling process involves reviewing a range of GIS data to determine if there are strong associations between described species habitat and attributes recorded in GIS data available for use in the REM. Once strong associations are identified a revised set of descriptors of the model is described (called the "REM habitat model" to avoid confusion), and GIS processes are developed to produce a spatial model that reflects the descriptors. The outputs from this process are then reviewed to determine if the spatial model is consistent with the description.

Approximately 100 fauna species have detailed spatial habitat models developed through the above process. Coverage of the model of each species varies, as the habitat model is only developed for areas covered by the REM. This is typically on a project-by-project basis but is being transformed to a regularly maintained and complete Statewide coverage.

Some examples of REM habitat model descriptions are shown in Attachment 2. A full list of the current model descriptions is available on request. Spatial characteristics and patterns in these models vary considerably depending on model formulation, so no examples are provided.

[1] Forest Practices Authority (2014). Summary of threatened fauna species range boundaries and habitat descriptions. v1.7 August 2013, Forest Practices Authority, Hobart. Table is an updated summary of information in Forest Practices Authority and Threatened Species Section (2012). Review of Threatened Fauna Adviser: background report 2: Review of information on species & management approach. Forest Practices Authority, Hobart.

Attachment 1. Conceptual structure of biodiversity in the Regional Ecosystem Model



Attachment 2. Examples of REM habitat models

Species: Orange-bellied Parrot
Neophema chrysogaster

Species attribute	Definition
FPA attributes	
Core range	N/A
Potential range	The potential range of the orange-bellied parrot comprises the potential foraging range and the potential breeding range. [still to be developed]
Known range	N/A
Potential habitat	Potential habitat for the orange-bellied parrot comprises potential breeding habitat and potential foraging habitat. Potential breeding habitat is mature eucalypt forest and woodland, including copses amongst plains, with obvious hollows present. Potential foraging habitat is dunes, heathlands, coastal grasslands and saltmarshes.
Significant habitat	N/A
Other habitat definitions	N/A
CARSAG habitat model	N/A
Other information	Additional information on the species is contained in the Orange-bellied Parrot recovery plan (2006[2]), which includes a map of the Breeding Range and Non-breeding Range in Tasmania: "Eucalypt forest (in the breeding range) saltmarshes, coastal dunes, pastures, shrublands, estuaries, islands, beaches and moorlands, usually within ten kilometres of the coast, make up the diverse habitats used by Orange-bellied Parrots. Breeding habitat is a mosaic of eucalypt forest, rainforest, and extensive fire dependant moorland and sedgeland plains, intersected by wooded creeks, rivers and estuaries within the Tasmanian Wilderness World Heritage Area (Brown and Wilson 1982, 1984; Stephenson 1991). Nesting occurs predominantly in the hollows of live Smithton Peppermint *Eucalyptus nitida* in patches of forest throughout coastal southwest Tasmania, but focused within 20 km of Melaleuca and 5km of Birch's Inlet (Brown and Wilson 1984; Higgins 1999). The entire known breeding population is contained within the Tasmanian Wilderness World Heritage Area (in particular the Southwest National Park) and Southwest Conservation Area.

[2] Orange-belled Parrot Recovery Team (2006). National recovery plan for the Orange-bellied Parrot (*Neophema chrysogaster*). Threatened Species Section, Department of Primary Industries & Water, Hobart.
http://www.environment.gov.au/system/files/resources/f493ebf4-a19b-412c-ac15-413b7d413a69/files/orange-bellied-parrot-recovery.pdf

Species attribute	Definition
	On passage in western and northwestern Tasmania (including offshore islands) the species occurs in dunes, heathland, coastal grasslands, saltmarsh and pasture. On King Island, they mostly occur in saltmarsh dominated by Beaded Glasswort *Sarcocornia quinqueflora*, flanked by tall dense Swamp Paperbark *Melaleuca ericifolia* forest (Higgins 1999)." p3 of Recovery Plan
REM habitat model	1. Breeding habitat for the species is native vegetation containing mature forest elements (any density) in the breeding range, as defined in the 2006 Recovery Plan. 2. Foraging habitat is vegetation communities in the species inclusion list (see below) within either the breeding range or the foraging range, based on the map and description in the 2006 Recovery Plan.
Notes	The inclusions list for the species is the Tasveg communities in which the species has been recorded in the NVA since 1983 at accuracy <=500 mm and that are consistent with the descriptions of the foraging habitat: ARS ASS, AUS, AWU, GHC, MBS, SCA, SSC and SSK.
Data	Breeding range polygon generated from map in 2006 Recovery Plan. Foraging range polygon (outside of the breeding range) generated from the map and descriptions in the 2006 Recovery Plan, comprising the Breeding range, 10km inland of the coast from Veridian Point (SW Tas) to Sisters Beach (NW Tas), and King, Hunter, Three Hummock, Walker, Robbins and Perkins Islands. Vegetation mapping from Tasveg and/or NRP Atomic Planning Units data.
Model status	Model tested and used in the REM.

Species: Dwarf Galaxias
Galaxiella pusilla

Species attribute	Definition
FPA attributes	
Core range	The core range of the dwarf galaxiid incorporates known sites and the catchments above known sites.
Potential range	The potential range of the dwarf galaxiid is the broader catchments defined by specialists where the species may occur and where surveys have not been conducted.
Known range	N/A
Potential habitat	Potential habitat for the dwarf galaxiid is slow-flowing waters such as swamps, lagoons, drains or backwaters of streams, often with aquatic vegetation. It may also be found in temporary waters that dry up in summer for as long as 6-7 months, especially if burrowing crayfish burrows are present (although these will usually be connected to permanent water). Habitat may include forested swampy areas. Juveniles congregate in groups at the water surface in pools free of vegetation.
Significant habitat	Significant habitat for the dwarf galaxiid is all potential habitat and a 30 m stream-side reserve within the core range.
Other habitat definitions	N/A
CARSAG habitat model	APUs of riverine, wetland or water vegetation within 500 m of known locations, plus some areas individually tagged.
Other information	N/A
REM habitat model	1. LIST wetlands and 2D watercourses, and Tasveg wetlands, within the Core Range that are <50 m altitude. 2. Native riparian vegetation on Class 1, 2 streams in the Core Range that are <50 m altitude. 3. Native riparian vegetation on Class 3 and 4 streams in the Core Range that are <50 m altitude AND have a streambed slope (CFEV data) of <2 degrees.
Notes	82% of record locations that intersect stream buffers are on Class 2 streams. All NVA records with an accuracy <=200 m are on CFEV river sections with a slope of <2 degrees (CFEV data), and are also at <50 m altitude.
Data	Vegetation data from NRP Atomic Planning Units. LIST Hydarea layer. CFEV river sections data (contains bed slope data).
Model status	Model tested and used in the REM.
Known issues	DPIPWE advised on 30 January 2014 that it needs to develop a new range boundary for the species to correct erroneous TMAG data points. This occurred after the model had been developed and may need to be incorporated into a future revision.

Species: Glossy Grass Skink
Pseudemoia rawlinsoni

Species attribute	Definition
FPA attributes	
Core range	N/A
Potential range	The potential range of the glossy grass skink is a 5 km (radius) buffer centred on known sites.
Known range	N/A
Potential habitat	Potential habitat for the glossy grass skink is wetlands and swampy sites (including grassy wetlands, tea tree swamps and grassy sedgelands), and margins of such habitats.
Significant habitat	N/A
Other habitat definitions	N/A
CARSAG habitat model	N/A
Other information	N/A
REM habitat model	1. The Core Range (500 m buffer of known locations), excluding urban areas (Tasveg FUR, FUM). 2. Parts of the land system polygons that are within one kilometre of the Core Range and have any of the following characteristics: (i) are LIST freshwater features classified as wetlands, wet areas or floodplains; or (ii) are land components that are gentle lower slopes or lower plains with the Tasveg communities for wetlands ("A" codes), grasslands, (GSL, GCL) swamp forests (NLM, NME), forests known to occur on wet areas (DOV, DOW, DVS) or wet scrubs (SRI, SSC).
Notes	The Core Range data on the NVA is a 500 m buffer, not 5km. Some recorded locations are on the edge of urban areas, with the Core Range buffer extending into them. 78% of NVA records with accuracy <=500 m are on land components that are gentle lower slopes or lower plains.
Data	NRP Land systems components data. LIST Hydarea layer. Vegetation from NRP Atomic Planning Units. Additional data generated by a script embedded in the REM.
Model status	Model tested and used in the REM.
Known issues	DPIPWE advised on 30 January 2014 that the revised boundary developed by the FPA needs to be included in the repository on the NVA. This occurred after the model had been developed and may need to be incorporated into a future revision.

Species: Chaostola Skipper
Antipodia chaostola

Species attribute	Definition
FPA attributes	
Core range	The core range of the chaostola skipper is a 2 km (radius) buffer centred on the known sites.
Potential range	The potential range of the chaostola skipper is the distribution of *Gahnia radula* and *G. microstachya*.
Known range	N/A
Potential habitat	Potential habitat for the chaostola skipper is dry forest and woodland supporting *Gahnia radula* (usually on sandstone and other sedimentary rock types) or *Gahnia microstachya* (usually on granite-based substrates).
Significant habitat	N/A
Other habitat definitions	N/A
CARSAG habitat model	Sites identified by Neyland (1994[3]) as having good stands of *Gahnia radula* which provide suitable habitat for the species.
Other information	N/A
REM habitat model	1. Areas within 200 m of known locations. 2. Native vegetation in the Core Range that is dry eucalypt forest (Tasveg "D"), native grassland (Tasveg "G") or dry scrub types (SCH, SHL, SHU). 3. Native vegetation that is dry eucalypt forest (Tasveg "D"), native grassland (Tasveg "G") or dry scrub types (SCH, SHL, SHU) on land system polygons within 5km of the Core Range which are sedimentary or acid igneous (granitic) rock types, <300 m altitude and <750 mm rainfall
Notes	The use of *G. radula* and *G. microstachya* as a predictor of potential habitat on its own is not supported by data on environmental characteristics of the species recorded locations. 91% of Chaostola Skipper records occur on sediments (though the number of known sites is small so this figure may not be reliable). In comparison, only 42% of the *Gahnia* species records occur on sediments. There are additional strong associations with rainfall, with 82% of Chaostola Skipper locations in areas with <750 mm rainfall, and altitude, with 93% of locations on areas <300 m ASL. The species also has a strong association with distance from the coast, with no records locations more than 21km inland.
Data	
Model status	Model developed and tested.

[3] Neyland, M. (1994). The ecology & conservation status of three rare hesperiid butterflies in Tasmania. Wildlife Report 94/3, Parks & Wildlife Service, Hobart.

Species attribute	Definition
Known issues	DPIPWE advised on 30 January 2014 that it needs to update the range boundary for the species to include new populations at Grasstree Hill and Buckland. This occurred after the species model had been developed and may need to be incorporated into a future revision.