

MAPPING SUITABILITY OF HABITAT FOR THE GIANT FRESHWATER CRAYFISH, *ASTACOPSIS GOULDI*: BACKGROUND DOCUMENT TO GIS MAPPING LAYER



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1. BACKGROUND

The Tasmanian *Forest Practices Act 1993* requires that threatened species listed in both the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the Tasmanian *Threatened Species Protection Act 1995* are taken into account in the preparation of Forest Practices Plans (FPPs) both on Crown land and on private land. Section D3.3 of the Forest Practices Code (2000) states that threatened species will be managed in accordance with procedures agreed between the Forest Practices Authority and DPIW. The agreed procedures include the development and implementation of endorsed management prescriptions through consultation among landowners, Forest Practices Officers and relevant specialists.

The current management actions applied in FPPs for the protection of the giant freshwater crayfish (*Astacopsis gouldi*) habitat have been developed over the last six years by specialists within the Forest Practices Authority in collaboration with the Threatened Species Section, DPIW and other species experts (Forest Practices Board 2002). They are based on current knowledge and expert opinion and are endorsed by the Tasmanian Threatened Species Scientific Advisory Committee as required under section 96(c) of the RFA. They comply with the recommendations in the draft *A. gouldi* Recovery Plan current in 2000. They aim to minimise the impact of forestry operations on habitat for *A. gouldi*. In general they state that planning of operations carried out in catchments where *A. gouldi* occurs should aim to ensure maintenance of stream water quality and other aspects of habitat quality such as shading, snags, food input and free movement of individuals up and down stream. The details of the recommended actions (e.g., stream buffers) vary depending on the occurrence of *A. gouldi* or its habitat, size of the watercourse and type of operation.

Management prescriptions for forest dependent threatened species, including those for *A. gouldi*, are reviewed and updated regularly by specialists within the Forest Practices Board, in collaboration with the Threatened Species Unit, DPIW, as new information becomes available. Further development of effective management prescriptions for *A. gouldi*, however, has been hindered by a lack of information on the characteristics of habitat important for juvenile *A. gouldi* (as identified in the 2000 draft Recovery Plan). A research project completed in 2004 addressed this knowledge gap and defined habitat for juvenile *A. gouldi* (<40 mm carapace length) in mid-catchment and headwater streams (Class 2–4 streams) (Davies and Cook 2004; Davies et al. 2005).

The overall aim of this current project was to take the results of Davies et al. 2005 and couple them with information on the characteristics of habitat important to adult *A. gouldi* (Growth 1995; Horwitz 1990, 1991, 1994; Hamr 1990; Davies and Cook 2004, Davies et al. 2005; Walsh and Nash 2002; Walsh 2003; Webb 2001) to develop a ‘habitat suitability’ map for *Astacopsis gouldi*. The purpose of developing this mapping resource is to trigger the application of protective provisions of the Code, especially for Class 4 streams, in order to either protect habitat quality, or to facilitate its recovery/restoration when degraded by other existing or historical landuses. It can be used to identify locations with high existing and/or potential habitat suitability, independent of current conditions that may result from existing or historical landuse. Mapping for the current status of *A. gouldi* instream habitat condition (i.e. under current as distinct from natural conditions) is a separate task, and will be pursued for other applications.

This current project also involved preliminary validation of the mapping layer (Davies et al. unpublished data). The validation work is ongoing and may result in modifications to mapping rules if the need arises.

2. METHODS

2.1. Defining habitat features for *A. gouldi*

Key habitat features for *A. gouldi* were determined from available published information (Growthns 1995; Horwitz 1990, 1991, 1994; Hamr 1990; Davies and Cook 2004, Davies et al. 2005; Walsh and Nash 2002; Walsh 2003; Webb 2001) and expert opinion (P.E. Davies, L.S.J. Cook, T. Walsh, J. Jackson, A.M.M. Richardson). Key features associated with elevated densities and/or greater probability of occurrence of *A. gouldi* within its range, under undisturbed conditions, include:

Macro habitat (stream reach characteristics):

- elevations <400m, and particularly <250 m above sea level;
- low levels of silt substrate (<2%);
- high proportions of moss cover (>10%);
- higher proportions (10–30%) of boulder substrate;
- channel slopes <15%.

in

- wider streams at intermediate catchment sizes, typically 2 to 30 km²;

or

- small streams of:
 - 0.4 to 2 km² catchment area; and with
 - significant and sustained groundwater (spring) input leading to elevated perennial baseflows.

Meso-habitat (features within the stream channel):

- large rocks
 - big enough not to be easily dislodged by high flows or by platypus;
 - overlying coarser substrates (boulder, cobble or pebble);
 - 40 cm in diameter or greater and flat in profile with a distinct cavity underneath;
 - in riffles, runs and pools;
 - in mid-channel and channel edges;
 - not embedded in finer substrates (gravel, sand or clay).
- cavities
 - associated with overlying or underlying rocks but not excavated;
- logs
 - lodged in the stream bed with a suitable underlying cavity.

These macro-habitat characteristics of elevation, stream size (class), presence of groundwater contribution, and stream slope have been used to develop rules for mapping the relative suitability of instream habitat for *A. gouldi* throughout the stream drainage network *under natural conditions*, and to develop a field validation protocol. The mapping was done by GIS using available layers for stream drainage lines, geology etc.

The presence of a groundwater contribution to a Class 4 stream was identified by mapping ‘Geological Contact Zones,’ which are known to have a higher probability of contributions of groundwater to surface drainage, largely as a result of contacts between different geologies, and hence sustain permanent suitable habitat in Class 4 streams. There are a number of mapping issues

associated with this approach, but it was deemed the most consistent and relevant with the current resources available.

Recent survey work (Davies and Cook unpublished data) indicated that for catchments across a range of geologies, Class 4 streams with overall average slopes of <10% had low habitat suitability for *A. gouldi* due to the absence of pool features as a result of low stream power and fine sediment storage, even when spring-fed groundwater supported baseflows during summer. Such channels often have poor channel definition and an absence of distinct instream habitat features such as pools which may act as refuges during very low flows. By contrast, surveys in Class 4 streams with steeply concave streamlines revealed suitable habitat in lower reaches even with slopes <10%, due to high stream power under flood conditions forming distinct channel (including pool) features.

In addition there are problems of scale when attempting to identify individual stream site slopes when using GIS drainage layers whose smallest stream line segments can range in size from hundreds of metres to kilometres. Slope rules were therefore developed to differentiate Class 4 streams with <10% overall average stream line section slopes (which have low habitat suitability) from those with overall average slopes between 10 and 30% (which have high habitat suitability), and those stream line segments with slopes <10% but which are downstream of segments whose average slope is >10% (which have high suitability). The accuracy of these rules is dependent on the average size of Class 4 line segments.

2.2. GIS methods used to develop the mapping layer

Details of the GIS methods used to develop the layer are provided in Appendix 1. The steps used were:

***A. gouldi* range**

1. Derive a GIS polygon layer of the range boundary of *A. gouldi* in Tasmania – sourced from the DPIW CFEV (Conservation of Freshwater Ecosystem Values) project data layers, reviewed and modified.

Stream drainage and catchments

2. Obtain a stream drainage layer mapped at 1:25000 scale which includes attributed Class 4 streamlines derived from LIST map and a statewide 25 m Digital Elevation Model (sourced from Forestry Tasmania);
3. Obtain a catchment layer which delineates small scale catchments for individual river segments (sourced from DPIW CFEV project data layers).

Geological Contact Zones

4. Derive a listing of all geological contact zones and their relevant geologies (criteria from PE Davies, Freshwater Systems and Mladin Latinovic, Mineral Resources Tasmania);
5. Source a polygon layer of all relevant geologies (from Mineral Resources Tasmania);
6. Group the geology codes to reflect the categories used to define geological contact zones;
7. Buffer stream drainage lines and geological polygons, overlay and join these layers;
8. Derive average stream section slope for all stream catchment and geological polygons by overlaying onto the DEM;
9. Apply the geological contact zone rules to identify all Class 4 stream polygons and segments which have zones.

2.3. Habitat suitability

10. Apply the habitat suitability mapping rules as per Table 1 to the stream sections, and attribute stream catchment polygons with a suitability rating based on the highest suitability rating recorded for stream sections within it.

Table 1. Rules applied for mapping instream habitat suitability for *A. gouldi*.

Stream Class	Average Elevation	Average slope	Geocontact	Suitability
1	<400m	10–30%	N/A	High
2	<400m	10–30%	N/A	High
3	<400m	10–30%	N/A	High
4	<400m	10–30%	Yes	High
1	<400m	<10%	N/A	High
2	<400m	<10%	N/A	High
3	<400m	<10%	N/A	Medium
4	<400m	<10%	Yes/No	Low*
1	<400m	30–100%	N/A	Medium
2	<400m	30–100%	N/A	Medium
3	<400m	30–100%	N/A	Medium
4	<400m	30–100%	Yes	Medium
1	>= 400m	<10%	N/A	Medium
2	>= 400m	<10%	N/A	Medium
3	>= 400m	<10%	N/A	Low
4	>= 400m	<10%	Yes	Low
1	>= 400m **	10–30%	N/A	Medium
2	>= 400m **	10–30%	N/A	Medium
3	>= 400m **	10–30%	N/A	Medium
4	>= 400m **	10–30%	Yes	Medium
1	>= 400m **	30–100%	N/A	Medium
2	>= 400m **	30–100%	N/A	Medium
3	>= 400m **	30–100%	N/A	Low
4	>= 400m **	30–100%	Yes	Low
1	All Other	All Other	All Other	Low
2	All Other	All Other	All Other	Low
3	All Other	All Other	All Other	Low
4	All Other	All Other	All Other	Low

* High if average slope of upstream reaches >10%

** High if suitability of section downstream has elevation <400 m and high suitability.

3. RESULTS AND DISCUSSION

The map provides a single layer of river section catchments attributed as either High, Medium or Low suitability. High or Medium suitability indicates that streams are believed to contain reaches with the potential for good quality habitat for *A. gouldi*. Low suitability implies that stream habitat conditions may naturally be patchy or of reduced suitability for *A. gouldi*, but does not imply that *A. gouldi* could not potentially be found in streams in these catchments. Some Low suitability reaches may have habitat naturally unfavourable to *A. gouldi*, or may have populations that are restricted or absent, or other genera (e.g. *Engaeus* or *Parastacoides*) may be present.

It is important to note that these attributions indicate the natural potential for habitat suitability, and do not reflect the impact of human disturbance on stream habitat quality or availability. They are

designed to assist in application of current management prescriptions (Forest Practices Board 2002) for forestry operations adjacent to streams in relation to protection of suitable habitat for *A. gouldi*.

A desire to augment protection of headwater streams is a priority, especially Class 4 streams as defined under the Forest Practices Code (2003), over and above the existing prescriptions in the Code. Higher order and larger streams provide most habitat for *A. gouldi*, although Class 4 streams do contain suitable habitat under certain circumstances.

Field surveys have been conducted to validate the suitability of stream habitat identified using the mapping rules described in this report. Results of this validation work are to be reported elsewhere.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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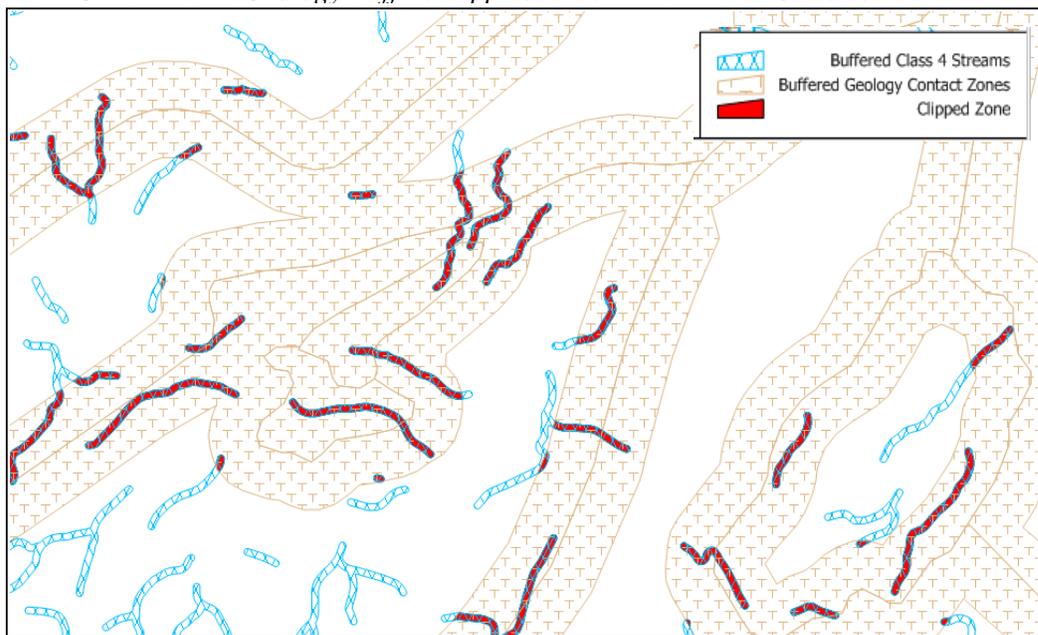
Appendix 1. Giant fresh water (GFC) crayfish modelling methods

The following sections describe the GIS methods used to derive the habitat suitability mapping layer for *A. gouldi* (or GFC) in streams.

Geological Contact Zones

1. Buffer the geological contact zones (that is, where one geology meets another or the boundaries of the contact zone), by the data's positional accuracy, which, according to Mineral Resources Tasmania (MRT), was ± 250 m.
2. Buffer the class 4 river sections by 17.5 m. According to the LIST, not less than 90% of 'well defined' data is within 17.5 m for data captured at varying scales using a variety of digitising techniques. Using a larger buffer distance often had an undesirable effect; that is, due to the often close proximity of class 4 streams, a larger buffer distance would sometimes overlap into neighbouring streams, thus creating one large messy buffer or in some cases an extended buffer network.
3. Clip out the geology buffer and the class 4 stream buffers by the Giant Freshwater Crayfish (GFC) range boundary.
4. Join the geology buffer and the class 4 stream buffers to create smaller areas that are essentially the geological contact zones but restricted to be within the buffered class 4 streams (Diagram I).

DIAGRAM I: The Geology Buffers clipped/intersected with the Class4 stream



5. Transfer the average elevation, from the 25 m Digital Elevation Model (DEM), to each individual polygon (Diagram II). Note that each polygon also carries with it the Geology code, inherited from the buffered geology zones (Diagram III).

DIAGRAM II: Average Elevation transferred to each polygon.

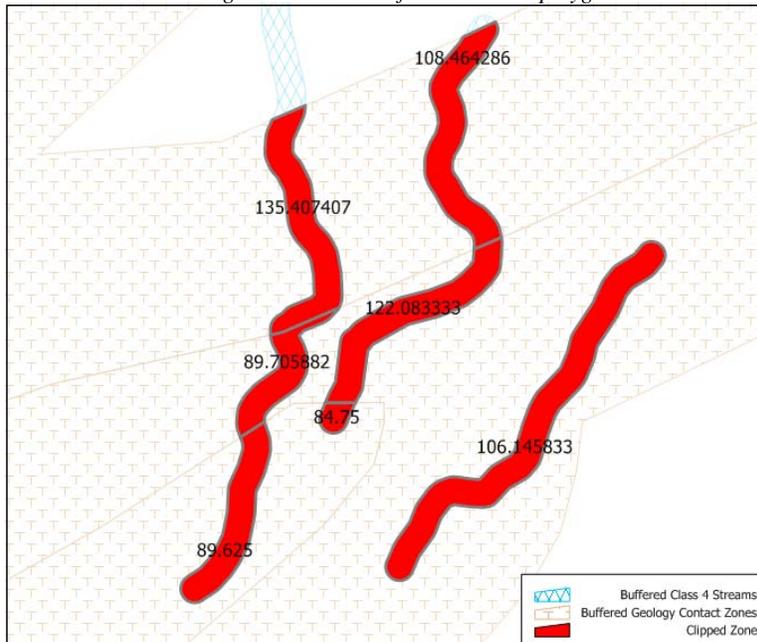
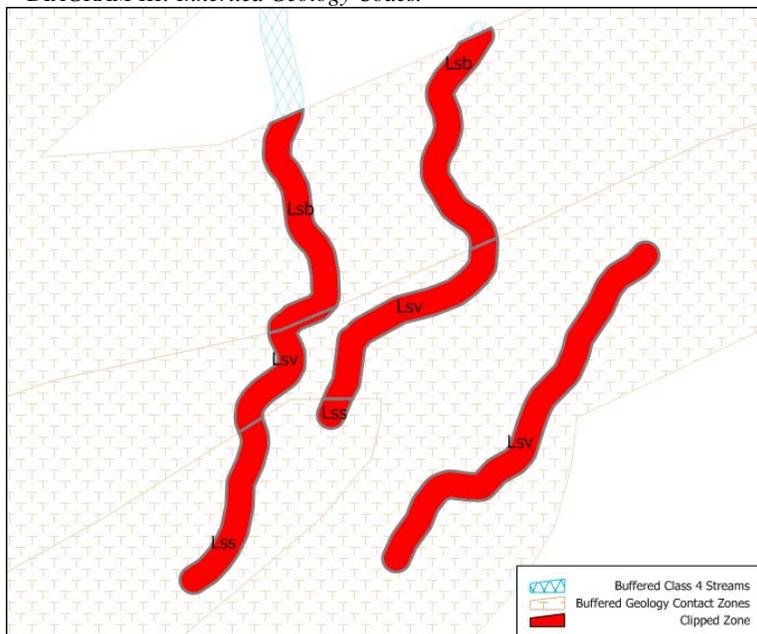


DIAGRAM III: Inherited Geology Codes.



- Group the geology codes to reflect the categories used to define the geological contact zones. The categories and groups are shown in Table 2.

Table 2. Geological contact zones and their corresponding geology codes.

Group	Geocontact zone	Geology Codes*
Basalt	Basalt in contact with other geology regardless of elevation	Cbt, Lsb, Tb
Tertiary	Tertiary sandstone in contact with other geology regardless of elevation	Tc
Dolerite Sandstone	Dolerite overlying sandstone Dolerite overlying Sandstone	COs, Cdsv, Lrb, Lrl, Lsc, ODq, Ol, Pc, Pf, Pu, Q, Qp, Qpt, R, Rq, Rv, Rvc, SD, Tc
M_Sandstone	Mathinna Sandstone overlying Mathinna Turbidites (Mudstones)	Odq
M_Mudstone	Mathinna Sandstone overlying Mathinna Turbidites (Mudstones)	ODp
Triassic	Triassic (sandstone) and Permian Mudstone overlying any Mudstone	R, Rq, Rv, Rvc
Mudstone	Triassic (sandstone) and Permian Mudstone overlying any Mudstone	ODq, P, Pc, Pf, Pl, Pt, Pu, SD
Quaternary	Quaternary deposits overlying any other geology	Q, Qh, Qp, Qpt
Coal Measures	Coal Measures in contact with any other geology regardless of elevation	Pc, Pf
Triassic/Permian	Triassic/Permian overlying Dolerite	P, Pc, Pf, Pl, Pt, Pu, R, Rq, Rv, Rvc

*Only the geology codes that were found in the clipped stream buffer/geology buffer were used in this table.

- Link the elevation and the geology information to the original buffered class 4 streams. In some cases, after linking the data back to the buffered class 4 streams, there were multiple elevation values for the one geology type. For example, stream section “X” has the geocontact groups “Dolerite” with elevation 62 m, “Sandstone” with elevation 60 m and “Dolerite” with elevation 58 m. Note that stream “X” has two of the same geology types, “Dolerite”, with two different elevations, 62 m and 58 m. To account for these situations, the geology with the highest elevation was kept and the lower ones were omitted. Referring back to the previous example, stream section “X” would subsequently have the geocontact groups “Dolerite” with elevation 62 m and “Sandstone” with elevation 60 m. In summary, there would be the one record “X” that has multiple attributes, being the geocontact groups, with the elevations as the values; see below for an example.

Stream	Basalt	Tertiary	Dolerite	Sandstone	M_Sandstone	M_Mudstone	...
X			62	60			

- Apply the geocontact zone rules, as showed in Table 2, so that if any stream section falls under these rules, it is coded as a geocontact zone. For instance, using the simple example above, stream section ‘X’ would be considered to have a geological contact zone. This is due to one of the rules stating that Dolerite is to be overlying Sandstone, and one can see that the average elevation of dolerite is higher than the average elevation of Sandstone. Note that geological fault lines were also considered to be geocontact zones. The fault lines were also buffered by the data’s positional accuracy of ±250 m. Any class 4 stream drainage that intersected the buffered fault lines were considered to be on a geocontact zone.

9. Using a spatial selection, the geocontact zones were transferred from the stream section buffers to the original stream sections. This was carried out by stating that if the stream physically touches a buffered zone that has been coded as having a geocontact zone, then the stream was also coded as having a geocontact zone on or near it. That is, within 17.5 m of the stream.

Habitat Coding

1. The habitat coding was separated into three categories: High Suitability, Medium Suitability, and Low Suitability. They were derived using the rule set shown in Table 1 (note that the special case of low slope Class 4 streams with steeper upstream sections, denoted with an * in the table was attributed separately – see later section). Sections with a ** were re-rated according to the suitability and elevation of the neighbouring downstream section. This rule set was applied to the drainage layer bounded by the GFC Range Boundary.
2. To apply the linear drainage model to an area model, the CFEV River Section Catchments layer was used. The drainage sections used did not match the CFEV drainage sections; hence they did not match the CFEV River Section Catchments layer either. As the CFEV River Section Catchments layer was the only layer available at the time that broke larger catchments down into river section catchments, it was decided to use it as a basic area model. This was accomplished by spatially overlaying the linear drainage model on top of the CFEV River Section Catchments layer. Those catchments that may have had more than one suitability transferred into them via the linear drainage model, for example High Suitability and Medium Suitability, were coded as having the highest value, where High Suitability is considered the highest value and Low is the lowest. The rest of the catchments, that did not have the linear drainage model intersecting them, were then coded using the rules specified in Table 1.
3. Field investigations confirmed that sections with <10% slope but which were downstream of several sections of >10% slope frequently had well defined channels and were capable of supporting instream habitat. These sections were then re-attributed as follows:
 - Class 4 streams with average slope less than 10% were selected (these had been attributed with a low suitability).
 - These areas were selected from the suitability map based on river catchment polygons.
 - All class 4 streams were selected and intersected with the CFEV river layer.
 - The CFEV river segments that intersected the low suitability polygons from the first step were selected.
 - The slope values from these polygons were joined to the CFEV river segments.
 - A column in the resulting layer was produced that gave each slope value a corresponding 'Number' from the CFEV attributes.
 - All records were then selected that were higher than 'Number' and less than or equal to 'UPNUMBER', which is a CFEV attribute that gives the total number of stream segments from a sink to a headwater.
 - From this selection all segments with a slope greater than or equal to 10% were selected.
 - The resulting selection therefore included all river sections upstream of a low suitability polygon (slope less than 10%) that had a slope greater or equal to 10%.
 - These segments were intersected with the low suitability polygon layer and selected polygons were given a 'high suitability' value. These polygons were intersected with the habitat suitability layer in order to update the final layer.