IVG Forest Conservation Report 3A

Assessment of locations of refugia for ancient and relictual invertebrate fauna within the proposed ENGO forest conservation areas

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An important part of the work of the Independent Verification Group for the Tasmanian Forest Agreement is an evaluation of the conservation values and boundaries of reserves from within the ENGO-nominated 572,000 hectares; the proposed ENGO forest conservation areas. This report is a component of that verification of values. It deals with the conservation assessment of locations of refugia for ancient and relictual invertebrate fauna within the proposed ENGO forest conservation areas.

Although there is considerable interest in adding a phylogenetic component to the assessment of species conservation priorities (eg Faith 2008, http://www.edgeofexistence.org/), such efforts are entirely dependent on well-supported and reliable phylogenies; previous attempts have been confined to groups for which such phylogenies exist, e.g. Australian freshwater crayfish (Whiting *et al.* 2000). The invertebrate "group" is very large and highly diverse; it is not in any sense equivalent to the vertebrates, containing as it does tens of phyla as against the single Phylum Chordata. Few species-level phylogenies exist for the Tasmanian fauna; however, Tasmania supports a significant number of relictual or "ancient" faunal groups, and while some of the species are quite widespread they certainly represent a value that should be taken into account in land use planning.

Given the limited information available for invertebrates the approach taken here has relied on subjective assessments of the phylogenetic significance of taxa, often found in the Comments sections of taxonomic monographs and reviews (eg The Insects of Australia). Distribution data for these taxa have been collected from the Tasmanian Department of Primary Industries, Parks, Water & Environment's Natural Values Atlas, the scientific literature, websites and unpublished data. Polygons were drawn around point records, usually as minimum convex polygons, but where additional information was available from other sources these were modified accordingly. Polygons for each taxon were overlain on the IGA base map of potential reserves and the intersections were recorded.

1) Statement of global and national conservation significance of Tasmanian endemic invertebrates.

The list below is derived from the literature, websites and contacts with experts. Groups for which information is very sparse or non-existent have been omitted. The invertebrates cover a vast range of groups and information is commonly non-existent or hard to locate. High level, reliable phylogenetic information is only available for a few groups, thus judgments about the age of taxa are mostly based on subjective comments by invertebrate systematists in the literature.

The distinction between national and global significance is hard to make for these groups. Given the uniqueness of Tasmania within the isolated Australian fauna it seems appropriate to categorize all these groups as globally significant.

The information base is summarized in Appendix Table 1. Only recognized globally significant groups are identified.

Platyhelminthes (Flatworms)

Probably contains a high level of as yet undiscovered diversity that is likely to include ancient/relictual species. Currently, only an informal guide to identification exists (Leigh Winsor), but using it on student field trips between Bronte Park and Cardigan Flats along the Lyell Hwy revealed at least 16 spp in 7 genera.

Mollusca (Snails & slugs)

Terrestrial species

While the alpha-taxonomy of Tasmanian terrestrial molluscs is improving, phylogenetic understanding remains uncertain for the whole Australian fauna. Levels of endemism are very high at the species and genus levels, and some families appear to show Gondwanan relationships.

F. Caryodidae

Two large endemic species occur in Tasmania, both in monospecific genera. *Caryodes dufresnii* is widespread in forests and other habitats, but *Anoglypta launcestonensis* is restricted to the NE Highlands. The Family first appears in the fossil record in the Eocene and is probably most closely related to the Acavidae from the Seychelles, Madagascar and Sri Lanka, suggesting a Gondwanan connection (Smith & Kershaw 1998a).

F. Rhytidae

Five of the seven species are Tasmanian endemics. The family is also known from S Africa, Seychelles, Mascarenes, New Caledonia and New Zealand, and is likely to be Gondwanan (Ponder *et al.* 1998).

F. Cystopeltidae

Two Tasmanian species (*Cystopelta petterdi* and *C. bicolor*) occur in this family, which is one of a small number of relictual terrestrial molluscs families with restricted distributions and uncertain phylogenetic relationships (Smith & Kershaw 1998b).

Freshwater species

The freshwater mollusc fauna is better-known, though the same lack of clear phylogenetic information remains. Tasmania supports major radiations of hydrobiid snails.

F. Glacidorbidae

This unusual family has representatives in Australia and South America. Two species (*Glacidorbis pedderi* and *G. pawpela* listed as rare) occur in Tasmania (Ponder & Avern 2000).

F. Planorbidae

Amongst this widely-distributed family the endemic Tasmanian genus *Ancylastrum* is unusual for its limpet-shaped shell and restricted distribution (Ponder *et al.* 1998).

F. Hydrobiidae

Ponder *et al.* (1993) described the radiation of species in the Beddomeia group in Tasmania, recording a large number of species with highly restricted distributions in three endemic genera: *Beddomeia*, *Phrantela* and *Nanocochlea.* This is one of two major hydrobiid radiations in Australia, and while the other is related to faunas in New Zealand and New Caledonia, the Tasmanian radiation has no clear relationships with taxa elsewhere (Ponder *et al.* 1998). Many of these species are listed as threatened under the *Threatened Species Protection Act*.

Annelida (Earthworms)

Recent analysis of the New Zealand earthworm fauna (Buckley *et al.* 2011) suggests ancient clades dating to the separation of Gondwana, and similar ancient clades are likely in the Tasmanian fauna. The checklist produced by Blakemore (2007) suggests high diversity, however very few distributional data are available.

Onychophora (Velvet worms)

The most recent review of this group in Australia notes "all Tasmanian species are especially important because of the antiquity of their evolutionary lineage and their endemicity" (Reid 1996). The oldest elements of the Australian velvet worm fauna are confined to Tasmania and south-eastern mainland Australia, and are related to taxa from South America, South Africa and New Zealand. The Tasmanian species are deeply separated from the rest of the Australian fauna in a cladistics analysis and are more closely related to New Zealand genera. Two species are nationally listed under the *Environment Protection & Conservation Act* and the *Threatened Species Protection Act* as endangered.

Crustacea

Syncarida (Mountain shrimps)

F. Anaspididae

The mountain shrimps are perhaps the best-known "ancient" animal species in Tasmania. Jarman and Elliott (2000) provide DNA evidence to suggest that the extant Anaspididae were derived from a common ancestor at 55 Myr BP, with further speciation events at 26 Myr (the two *Allanaspides* spp), 25 Myr (*Paranaspides*; *Anaspides* sp 3) and 12 Myr (*Anaspides* spp 1& 2).

F. Koonungidae & Psammaspididae
Smaller species in the genera *Koonunga*, *Micraspides* and *Eucrenonaspides* are found in interstitial waters and crayfish burrows in western and northern Tasmania. Phylogenetic information is lacking, but they are also likely to have ancient histories.

Amphipoda: freshwater (Scuds)

Australia has a richer diversity of freshwater amphipod genera than the other continents, reflecting the very old history of the group. One major group of freshwater amphipods, the Crangonyctoidea, has relatives on both northern and southern continental masses, indicating their origin in Pangaea, preceding the separation of Gondwana from Laurasia (Williams & Barnard 1988). DNA-based analysis of the type performed on the Anaspididae (above) is likely to show a similar patterns of ancient clades, despite morphological conservatism. Once again, taxonomic and distributional data for the Tasmanian species is sparse (Bradbury and Williams 1999), but species in endemic genera in the Paramelitidae (*Antipodeus* spp) and all genera in the Neoniphargidae (*Neoniphargus, Tasniphargus* spp, *Yulia yulia*) should be considered “ancient”.

Amphipoda: terrestrial (Landhoppers)

F. Talitridae

The 16+ species of landhopper recorded in Tasmania have been divided informally into two, the simplidactylate and cuspidactylate groups, by Bousfield (1984). The simplidactylate group (6 genera and 13+ species) shows strong Gondwanan connections with South Africa, while the cuspidactylates (2 genera and 3+ species) display more plesiomorphic characters, closer to those of the putative sister group, the intertidal Hyalidae (Friend 1987) and may be the more ancient group.

Isopoda: freshwater

Phreatoicoidea

Phreatoicids (no other common name) are an important component of the freshwater crustacean fauna in Tasmania, and once again have an ancient and Gondwanan history (Knott 1975, Wilson, 2008a). Species in the Hypsimetopidae (*Phreatoicoides* in Tasmania) became cave-adapted around 130 Myr BP, and blind epigean forms emerged at least 80 Myr BP. Triassic fossils have been found that are similar to the extant endemic Tasmanian genus *Onchotelson* (Phreatoicidae). Great Lake supports an important cluster of endemic genera (*Mesacanthotelson, Onchotelson, Uramphisopus*).

F. Janiridae

Species in the genus *Heterias* are regular members of the interstitial crustacean fauna of swamps, seepages and crayfish burrows in western Tasmania, along with koonungid syncarids, hypsimetopid phreatoicids and crangonyctoid amphipods. They have a Gondwanan origin (Wilson 2008b). The crustacean seepage fauna in western Tasmania represents a phylogenetic value in itself.

Isopoda: terrestrial (Woodlice, slaters)

Very little work has been done on Tasmania's terrestrial isopods since that of Green (1961, 1963, 1971, 1974), despite their relative abundance in forest leaf litter. The "primitive" terrestrial genera in the Styloniscidae: *Styloniscus* and *Notoniscus* have Gondwanan relatives (Green 1974).

Parastacidae (Freshwater crayfish)

All Australian crayfish are placed in the Family Parastacidae, which clearly had its origins in early Gondwana (other species in Madagascar, New Guinea, New Zealand & S America). The Tasmanian fauna is almost entirely endemic (three out of five genera and all but two of the 37 species). Two sister genera, *Ombrastacoides* (11 spp) and *Spinastacoides* (3 spp), are deeply separated from the others Australian genera, showing closer associations with New Zealand and South American clades than those on the Australian mainland (Hansen & Richardson 2006, Sinclair *et al.* 2004). Two species are nationally listed under the *Environment Protection & Conservation Act* and the *Threatened Species Protection Act* as endangered, and two species as vulnerable. One species is listed as endangered in Tasmania..

Non-malacostracan crustaceans

No attempt has been made to cover the lower crustaceans, despite the diversity of copepods, ostracods etc, because of the lack of distributional data.

Arachnida

Aranea (Spiders)

The Tasmanian spider fauna is diverse, but only patchily known, usually as a result of habitat studies: eg heathlands (Churchill 1999) or caves (Eberhard *et al.* 1991, A.K. Clarke unpubl.). Species of phylogenetic and evolutionary interest are found in the mygalomorphs (*Plesiothele fentoni*) and hypochilomorphs (*Hickmania troglodytes*: Doran *et al.* 2001, Forster *et al.* 1987). *H. troglodytes* is a member of a relictual group that represents the primitive araneomorph spiders; other family members occur in Chile and Argentina.

Other cave spiders of interest include *Tupua* (Synotaxidae): endemic genus, Gondwanan family, and *Icona* (Theridiidae): related species only know from New Zealand subantarctic islands.

Opiliones (Harvestmen)
The slow-moving but spectacular harvestmen (Laniatores) are diverse and relatively common in forest litter and logs (Hunt 1990, 1992, 1995, Hunt & Hickman 1993)but the only distributional data comes from cave surveys (Eberhard *et al.* 1991, A.K. Clarke unpubl.). The phylogenetic history of the group in Tasmania is unclear, but ancient species are likely.

Pseudoscorpiones (False scorpions)

As with the harvestmen, the only systematic distributional data comes from cave surveys (Eberhard *et al.* 1991, A.K. Clarke unpubl.) and the "ancient" status of taxa in the group is uncertain.

Myriapoda

Chilopoda (Centipedes)

Among the centipedes *Craterostigmus tasmanianus* was described by its original discoverer as "a species which proves to be comparable in interest from a morphological standpoint to either or its compatriots, *Ceratodus* [the Australian lungfish] or *Ornithorhynchus* [the platypus], inasmuch as it unmistakably represents an archaic type which has survived in this isolated corner of the world" (Edgecombe & Giribet 2008). Then Tasmanian Multipede (Mesibov 2011) website provides distributional data.

Diplopoda (Millipedes)

This group is becoming increasingly well-known taxonomically and biogeographically in Tasmania, thanks to the work of Mesibov (eg the Multipede website), but the overall phylogenetic picture, and the status of ancient species, remains unclear.

Insecta

Collembola (Springtails)

The sub-family Uchidanuridae within the Neanuridae includes the world's largest springtails and is considered an ancient group. The monospecific genus *Megalanura* is endemic to Tasmania (Greenslade 1991).

Odonata (Damsel and dragonflies)

The small damselfly *Hemiphlebia mirabilis* is considered an archaic member of the group, possibly a sister to all the other zygopteran families (Theischinger & Enderby 2009).

Synthemistinae is a southwest Pacific sub-family within which the Tasmanian endemic monospecific genus *Synthemiopsis* is considered the most archaic. Similarly, the Tasmanian endemic monospecific genus *Archipetalia* is considered the most archaic of the Gondwanan Neopetaliidae (Allbrook 1979, Watson *et al.* 1991).

Isoptera (Termites)

Termopsidae includes "relict, primitive genera" of Gondwanan origin. *Stolotermes* has one endemic species in Tasmania (Watson & Gay 1991).

Hemiptera (True bugs)

The Tasmanian endemic hairy cicada, *Tettigarcta tomentosa*, is one of two species in the Tettigarctiidae, a primitive family know elsewhere as fossils in the N Hemisphere Mesozoic and Tertiary (Moulds & Carver 1991).

The Peloridiidae are placed in their own Infraorder, reflecting their primitive features. The family is Gondwanan (Carver & Gross 1991).

Lepidoptera (Moths & butterflies)

The Pine Looper moths, *Dirce* spp, are endemic to Tasmania, and are members of a sub-family which has its only other members the southern Andes and the boreal N Hemisphere, suggesting a very ancient origin.

2) Known locations of ancient invertebrate faunal taxa and a map of forest locations that function as evolutionary refugia for these groups.

Maps showing point records and distribution polygons for each of the 20 ancient invertebrate taxa identified in the survey above are shown in Appendix Figs 1- 20.

Figure 1 shows the number of these taxa that intersect the proposed ENGO reserves. Western reserves clearly score more highly than those in the east, and sites in the central south consistently show the highest scores. Appendix Table 2 gives the presence/absence of each taxon in the 270 proposed ENGO forest conservation areas

Key proposed ENGO reserves that protect ancient invertebrate faunal taxa are 2, 6, 11, 18, 19, 20, 23, 24, 25, 26, 30, 32, 33, 34, 35, 44, 50, 52, 58, 59, 61, 62, 64, 66, 67, 69, 79, 80, 81, 85, 88, 90, 92, 96, 98, 102, 105, 111, 143, 149, 198 and 244.

Faunal break areas are found in 58 ENGO proposed reserves - 94, 98, 102, 105, 111, 1, 3, 38, 54, 78, 86, 89, 99, 101, 132, 137, 144, 150, 152, 157, 158, 159, 160, 167, 173, 224, 230, 252, 254, 259, 269, 29, 42, 45, 47, 57, 65, 70, 93, 117, 133, 138, 154, 164, 169, 170, 180, 188, 195, 201, 203, 214, 233, 251, 255, 256, 260 and 262.

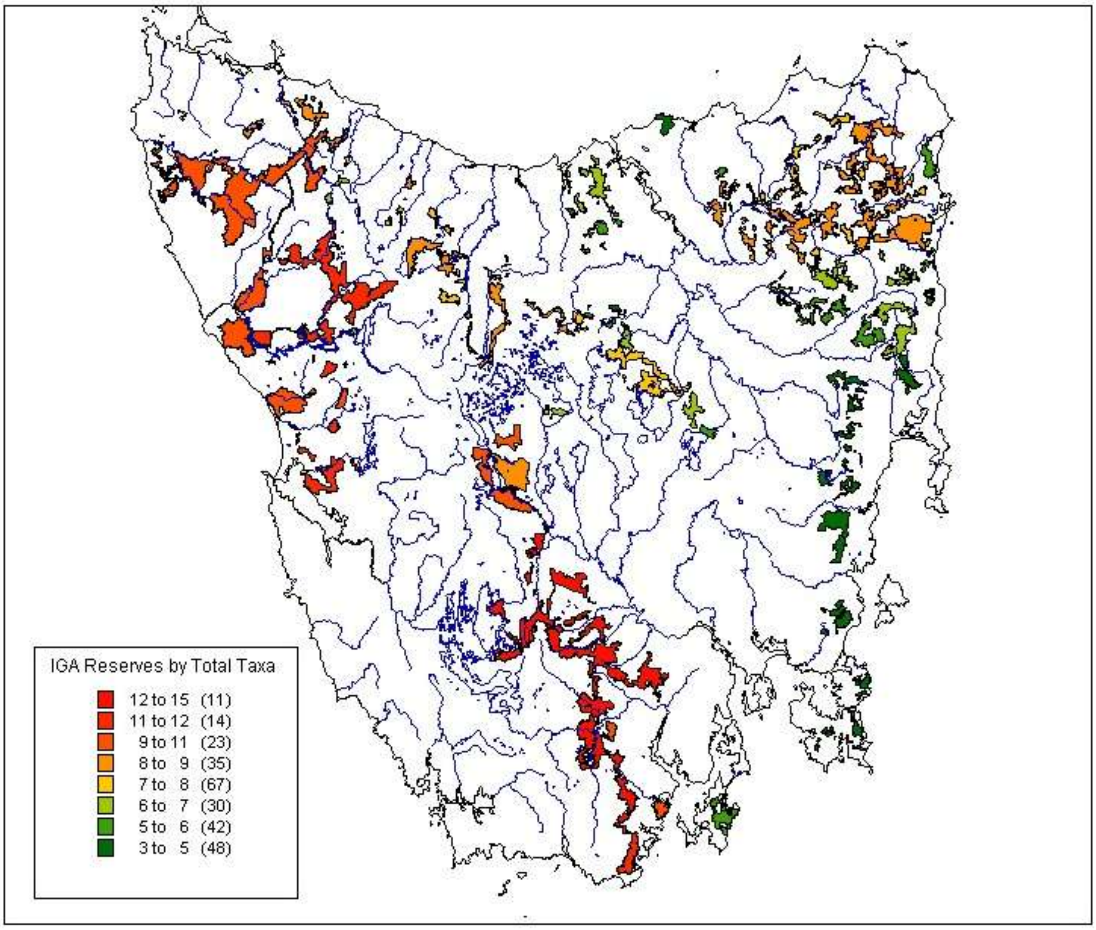

Figure 1. Proposed IGA reserves shaded to show the occurrence of 20 invertebrate taxa of phylogenetic or biogeographical importance.

3) Identification of places important in the evolutionary history of invertebrate faunal taxa (places of high invertebrate diversity, outlier populations, important species disjunctions etc).

Figure 1 suggests that western Tasmania is an area of high invertebrate diversity and includes the highest proportion of ancient species. At a smaller scale, local hotspots of invertebrate diversity exist in and around Great Lake (endemic genera of phreatoicids, *Paranaspides*, *Tasniphargus*) and the West Coast Range (*Ombrastacoides* spp.), also in the far northwest and the northeast highlands. However, the comments of Mesibov (1996) in regards to the unreliability of identifying hotspots given the cover and precision of distributional data should be noted.

Mesibov (1994, 1996, 1997, 1999) has made a strong case for the existence of “faunal breaks” in the Tasmanian landscape, ie zones across which species composition changes sharply, usually as linear features, such as Tyler’s Line, though in one case perhaps delimiting an area: Plomley’s Island in the northeast highlands. Although the processes involved in creating and maintaining these features are not always clear they represent important biogeographical phenomena, ones which have probably been lost in more developed landscapes elsewhere in Australia. Mesibov (1996) identifies three well-defined breaks: Tyler's Line, the East Tamar Break and the Goulds Country Break.

Tasmania's relatively undisturbed landscapes have also preserved some sharp parapatric[1] boundaries between species; these are also phenomena of great interest in understanding speciation and biogeographical processes. The boundary between the velvet worms *Tasmanipatus barretti* and *T. anophthalmus* near St Helens is a striking example (Horner 1995), and Mesibov (1996, 1997) records others between myriapod species and crayfish, such that between *Engaeus leptorynchus* and *E. mairener*, which is also respected by two species of *Lissodesmus* millipedes. In southwestern Tasmania parapatric boundaries exist between burrowing crayfish species around the Lake Pedder basin (Richardson *et al.* 2006).

Mapping these areas to contribute to an assessment of potential IGA reserves is difficult because of lack of precision in mapping data and the incomplete cataloguing of these phenomena. Maps showing the intersections of some hotspots, the three best-defined faunal breaks and well-know parapatries are shown in Figures 2-4. Appendix Table 2 includes all the potential reserves intersected by these values.

[1] Parapatry is a biogeographic term referring to organisms whose ranges do not significantly overlap but are immediately adjacent to each other; they only occur together in the narrow contact zone, if at all.

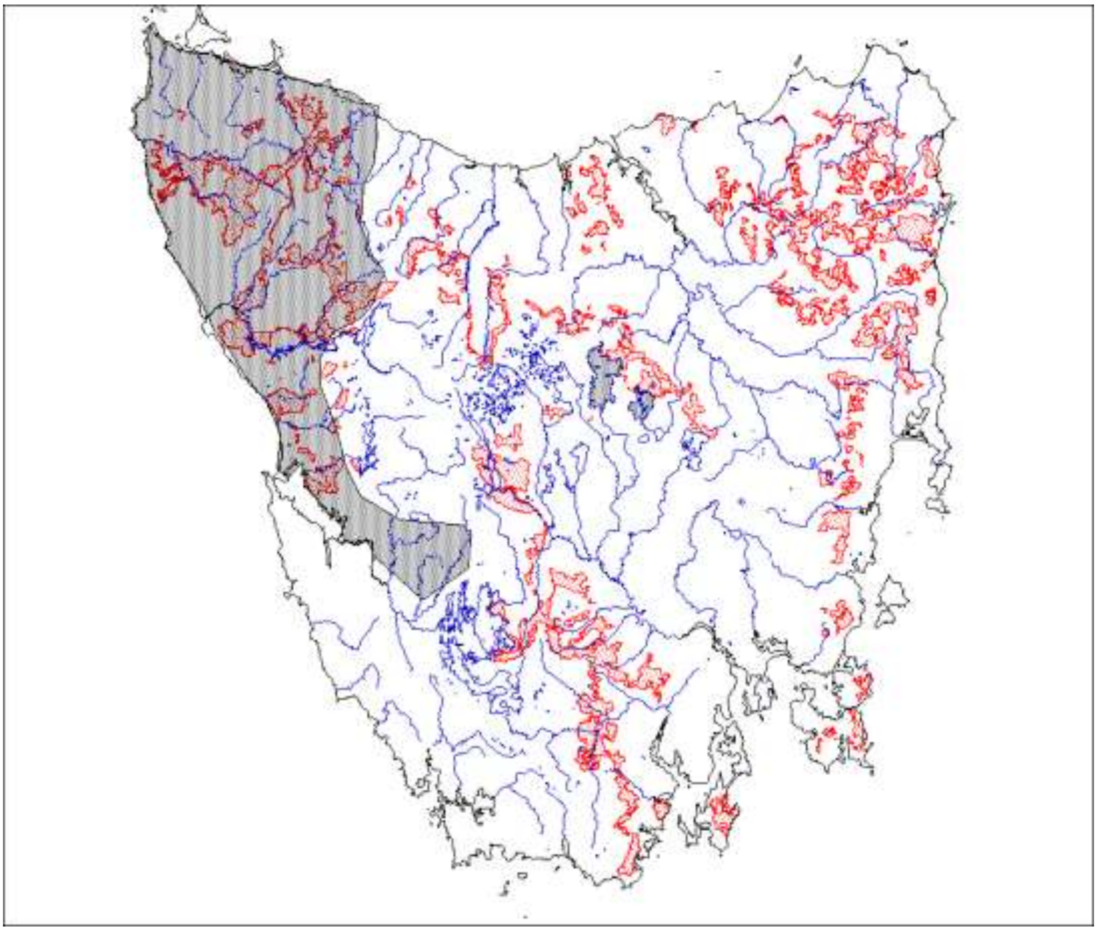

Figure 2. Potential IGA reserves and hotspots of phylogenetic interest. The extensive area in the west and northwest represents the distribution of the crustacean seepage fauna. A 1km buffer around the Great Lake and Arthurs Lake hotspots intersects areas 95 & 97. Areas intersecting the crustacean seepage fauna are given in Appendix Table 2.

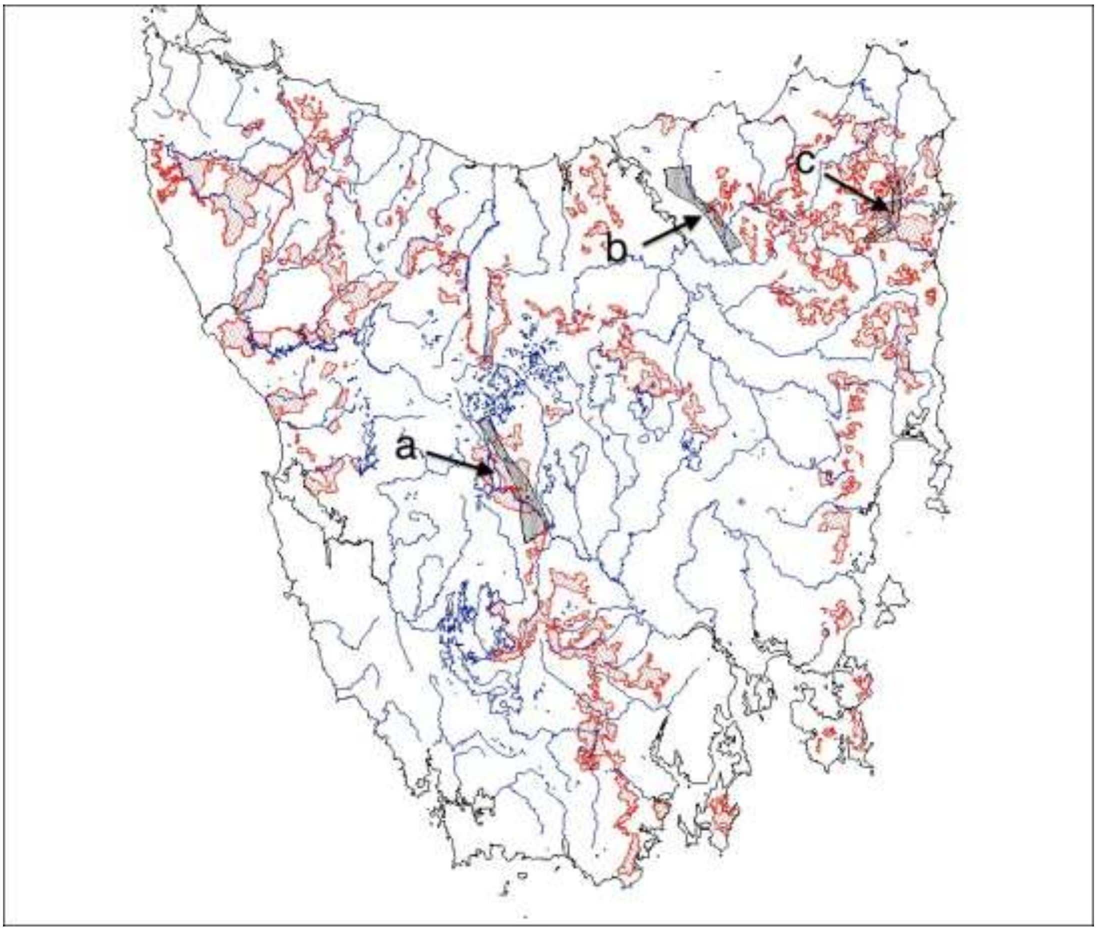

Figure 3. Potential IGA reserves and the three best-defined faunal breaks in Tasmania: (a) Tyler's Line, (b) the East Tamar break and (c) the Goulds Country break. Tyler's Line intersects areas 35-38, 43, 44, 54 & 64. The East Tamar break intersects area 212, the Goulds Country break intersects areas 193, 197, 207 & 258.

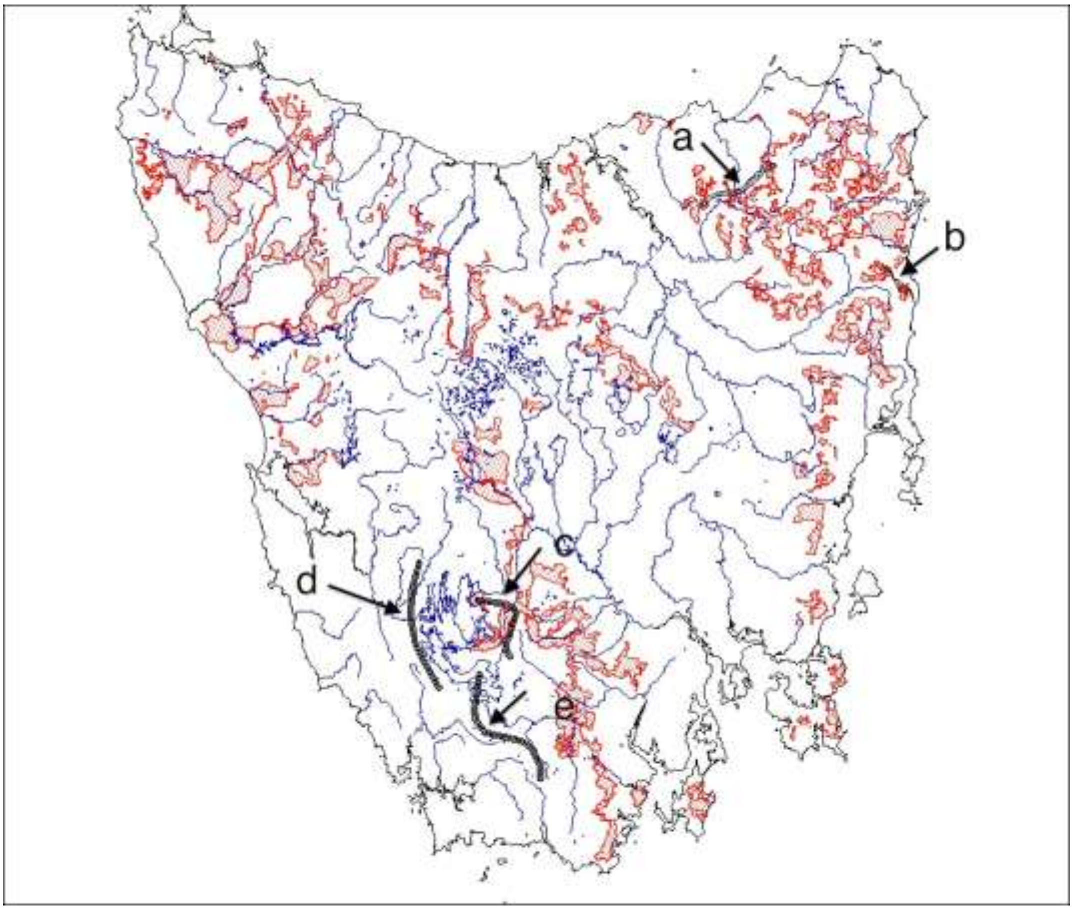

Figure 4. Potential IGA reserves and some parapatric boundaries for ancient and relictual invertebrate fauna. a: *Engaeus leptorynchus* and *E. mairener*, and *Lissodesmus* spp; b: *Tasmanipatus barretti* and *T. anophthalmus*; c: *Ombrastacoides decemdentatus* and *O. huonensis*; d: *O. brevirostris* and *O. huonensis*; and e: *Spinicaudatus insignis* and *S. inermis*. Parapatry a intersects areas 204, 212, 224 & 236; b intersects areas 128, 129 & 150. The Pedder area parapatries (c, d & e) intersect areas 23 & 30.

4) Updating of the distribution map of key invertebrate faunal taxa.

See above.

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