Appendix A

Regional Ecosystems in the Wet Tropics Bioregion

Legend: Wet Tropics Interim 1999 Remnant Regional Ecosystem Mapping

Note: This legend is for the Wet Tropics interim 1999 remnant regional ecosystem (RE) mapping certified as a regional ecosystem map under the Vegetation Management Act at the end of April 2002. The mapping was compiled by the Queensland Herbarium, whilst the coverage is currently being distributed by the Department of Natural Resources and Mines.

This mapping excludes the Townsville and Atherton 1:250,000 mapsheets which were certified previously, and which complete the Wet Tropics bioregion. The mapping and legends for these two mapsheets need to be obtained separately. The coverages can be obtained from the Department of Natural Resources, and the legends from the Queensland Herbarium, Toowong.

Table 1 is included here to assist with comparison of the Wet Tropics section of the Townsville 1:250,000 regional ecosystem mapping with the Wet Tropics Interim RE mapping.

Table 2 is to accompany the Wet Tropics interim RE mapping certified in April 2002. The Wet Tropics interim mapping includes approximately 23,600 hectares where no RE has been determined. These polygons have been labelled with the code 9999.

An a, b, or c after the RE indicates a sub-unit (land type or vegetation type) of the RE. An "ra" indicates rainforest at a successional stage after disturbance such as logging, clearing or fire. The species composition differs from the original ecosystem (but is dominated by rainforest species), and the structure is simpler. Although heavily disturbed, these areas meet the criteria of "remnant" under the Vegetation Management Act. Similarly the code "rs" indicates sclerophyll ecosystems which are highly disturbed but which meet the definition of "remnant". The a, b, c's, ra's and rs's have not yet been fully mapped over the whole bioregion.

Table 1: Equivalent REs in Wet Tropics section of the Townsville mapsheet Version 3.0 release, where the codes differ to those in the Wet Tropics interim mapping.

Townsville 1:250,000 mapsheet REs	Wet Tropics Interim equivalent RE
7.1.2x	7.1.2
7.2.2	7.2.2x1
7.2.4x	7.2.4
7.3.19x1	7.3.19
7.3.19x2	7.3.19
7.3.8x1a	7.3.8
7.3.8x1b	7.3.8
7.3.7x	7.3.7x1
7.3.1x	7.3.1
7.3.23x	7.3.23
7.12.31x	7.12.31x1
7.12.23x	7.12.23

Table 2: REs found in the Wet Tropics Interim RE mapping certified in Oct 2001 (excludes Townsville and Atherton 1:250 000 mapsheets).

Note: a,b,c's, rs, and ra, within bioregion 7 REs have not necessarily been treated across the whole study area. (Calculations of area etc. will therefore not be accurate for a, b, c's, ra, rs, and it would be best to group them into their REs for this purpose).

RE	description	original source of RE
3.2.28	Evergreen notophyll vine forest on beach ridges on coral atolls, shingle cays and sand cays.	Neldner and Clarkson (1995): 122
3.2.31	Premna serratifolia closed scrub. Restricted to coral atolls, shingle cays and sand cays.	Neldner and Clarkson (1995): 162
3.3.1	Closed semi-deciduous mesophyll vine forest. Mainly occurs on loamy alluvia and footslopes.	Neldner and Clarkson (1995): 8
3.3.2	Semi-deciduous mesophyll/notophyll vine forest. Occurs on alluvia.	Neldner and Clarkson (1995): 10 Tracey (1982): 1c
3.3.6	Evergreen notophyll vine forest with Melaleuca leucadendra on swamps (palustrine wetland).	Neldner and Clarkson (1995): 19
3.3.20	Corymbia clarksoniana ± Erythrophleum chlorostachys woodland on alluvial plains.	Neldner and Clarkson (1995): 63
3.3.21	Corymbia clarksoniana ± Syzygium eucalyptoides woodland. Lower slopes of sand ridges and in drainage depressions.	Neldner and Clarkson (1995): 64
3.3.28	Eucalyptus platyphylla ± Corymbia clarksoniana woodland on alluvial and colluvial plains.	Neldner and Clarkson (1995): 87
3.8.3	Eucalyptus leptophleba + Corymbia tessellaris + C. clarksoniana woodland on basalt flows	Neldner and Clarkson (1995): 79
3.11.1	Semi-deciduous mesophyll vine forest on coastal ranges, mainly in the central Peninsula.	Neldner and Clarkson (1995): 6 Tracey (1982): 4
3.11.3	Simple evergreen notophyll vine forest on exposed metamorphic and granitic slopes.	Neldner and Clarkson (1995): 26 Tracey (1982): 12a, 12b
3.11.12	Eucalyptus leptophleba, E. platyphylla woodland on rolling hills in southeast.	Neldner and Clarkson (1995): 81
3.11.13	Corymbia nesophila ± E. brassiana woodland on metamorphic hills and ranges in the southeast.	Neldner and Clarkson (1995): 82b
3.12.7	Eucalyptus brassiana, Corymbia clarksoniana open forest on McIlwraith and Melville Ranges.	Neldner and Clarkson (1995): 36
3.12.8	Corymbia clarksoniana ± C. tessellaris open forest on coastal ranges and lowlands.	Neldner and Clarkson (1995): 37
3.12.31	Themeda triandra tussock grassland on headlands and islands on acid volcanic rocks.	Neldner and Clarkson (1995): 189, 189b.
7.1.1	Mangrove forests on coastal lowland saline alluvial soils. (Estuarine wetland).	Kemp and Morgan (1999): 1 Kemp et al. (1999): 1 Neldner and Clarkson (1995): 34, 132 Stanton and Godwin (1989): 3, 38 Tracey and Webb (1975): 22a
7.1.1rs	Mangrove forests on coastal lowland saline alluvial soils. (Estuarine wetland). Regrowth or disturbed vegetation which meets the criteria of	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.

	"remnant vegetation" in the Vegetation Management Act.	

7.1.2	Salt meadow/ herbfield on coastal lowland hyper–saline alluvial soils. (Estuarine wetland).	Kemp and Morgan (1999): 2 Kemp et al. (1999): 2 Neldner and Clarkson (1995): 194 Tracey and Webb (1975): 22b
7.1.3	Bulkuru (Eleocharis dulcis) swamp on poorly drained acid peats. (Estuarine wetland).	Kemp and Morgan (1999): 3 Kemp et al. (1999): 3
7.1.3rs	Bulkuru (Eleocharis dulcis) swamp on poorly drained acid peats. (Estuarine wetland). Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.2.1	Mesophyll vine forest of very wet coastal lowlands on beach sands.	Stanton and Godwin (1989): 85, 87, 88, 101 Tracey and Webb (1975): 2b
7.2.1ra	Mesophyll vine forest of very wet coastal lowlands on beach sands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.2.2	Notophyll vine forest with acacia emergents of moist to wet coastal lowlands on beach sands.	Tracey and Webb (1975): 7b
7.2.2ra	Notophyll vine forest with acacia emergents of moist to wet coastal lowlands on beach sands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.2.2x1	Complex microphyll mixed mid-high closed forest (beach scrub) on dune ridges and swales in drier, southern provinces. Dominants include Syzygium forte subsp. forte, Pleiogynum timorense, Canarium australianum, Buchanania arborescens, Mimusops elengi, Drypetes deplanchei and Pouteria sericea.	Kemp and Morgan(1999): 5, and Kemp, Morgan and Cumming (1999): 5.
7.2.3	Dune ridge and swale vegetation mosaic of coastal lowlands.	Kemp and Morgan (1999): 4, 5, 6, 7 Kemp et al. (1999): 4, 5, 6, 7, 8, 9, 10 Neldner and Clarkson (1995): 20, 53C, 55, 93, 193, 198 Stanton and Godwin (1989): 4, 5, 17, 20, 25, 43, 44, 45, 46, 47, 48, 49, 51, 106, 107, 111, 112, 113, 116, 118, 119
7.2.3rs	Dune ridge and swale vegetation mosaic of coastal lowlands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.2.3x2	Strandline vegetation. Strongly zoned. Near prostrate vegetation along top of beach, with Ipomoea pes-caprae, Canavalia rosea. Treeline Casuarina equisetifolia +/- Hibiscus tileaceus, Vitex trifolia, Clerodendron inerme.	Qld Herbarium Townsville 1:250 000 mapsheet (Cumming): 330 (7.2.3x2), Kemp, Morgan and Cumming (1999): 4, Kemp and Morgan (1999): 4 and Stanton and Stanton (in prep.): 44.
7.2.4	Open forest/woodland vegetation mosaic (Corymbia spp., Lophostemon suaveolens, Eucalyptus pellita, Acacia spp.) of wet lowlands on old stranded dune ridges on sands.	Kemp and Morgan (1999): 8, 9, 10, 11, 12 Kemp et al. (1999): 11 Tracey and Webb (1975): 17

7.2.4rs	Open forest/woodland vegetation mosaic (Corymbia spp., Lophostemon suaveolens, Eucalyptus pellita, Acacia spp.) of wet lowlands on old stranded dune ridges on sands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.1	Sedgeland (Cyperus spp., Eleocharis dulcis, Baumea spp., Scleria poiformis) and grassland (Ischaemum villosum, Imperata cylindrica, Cynodon dactylon) freshwater swamp of seasonally inundated coastal lowlands (palustrine wetland).	Kemp and Morgan (1999): 13, 14, 15, 16 Kemp et al. (1999): 12, 13, 14, 15 Stanton and Godwin (1989): 37, 40, 41, 42, 120 Tracey and Webb (1975): 23a
7.3.1rs	Sedgeland (Cyperus spp., Eleocharis dulcis, Baumea spp., Scleria poiformis) and grassland (Ischaemum villosum, Imperata cylindrica, Cynodon dactylon) freshwater swamp of seasonally inundated coastal lowlands (palustrine wetland). Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.2	Sedgeland and grassland freshwater swamp of seasonally inundated tableland volcanic craters and alluvial depressions.	
7.3.3	Alexandra palm (Archontophoenix alexandrae) swamp vine forest on very wet poorly drained fertile lowlands (palustrine wetland).	Kemp and Morgan (1999): 17 Kemp et al. (1999): 16 Stanton and Godwin (1989): 22, 28, 29, 32, 95, 100, 105 Tracey and Webb (1975): 3a
7.3.3ra	Alexandra palm (Archontophoenix alexandrae) swamp vine forest on very wet poorly drained fertile lowlands (palustrine wetland). Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.4	Fan palm (Licuala ramsayi) swamp vine forest on very wet poorly drained seasonally inundated lowlands (palustrine wetland).	Kemp and Morgan (1999): 18 Stanton and Godwin (1989): 23, 30, 93, 94 Tracey and Webb (1975): 3b
7.3.4ra	Fan palm (Licuala ramsayi) swamp vine forest on very wet poorly drained seasonally inundated lowlands (palustrine wetland). Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.5	Swamp paperbark (Melaleuca quinquenervia) open forest on very wet and wet poorly drained lowlands (palustrine wetland).	Kemp and Morgan (1999): 19 Kemp et al. (1999): 17 Stanton and Godwin (1989): 8, 9, 10 Tracey and Webb (1975): 15a
7.3.5rs	Swamp paperbark (Melaleuca quinquenervia) open forest on very wet and wet poorly drained lowlands (palustrine wetland). Regrowth or disturbed vegetation which meets the criteria of	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.

	"remnant vegetation" in the Vegetation Management Act.	

7.3.6	Mixed paperbark (Melaleuca quinquenervia and/or M. leucadendra and/or M. dealbata) open forest, often with a well developed understorey of vine forest species, on very wet poorly drained lowlands (palustrine wetland).	Kemp and Morgan (1999): 20, 21, 22 Kemp et al. (1999): 18, 19 Neldner and Clarkson (1995): 19, 53C Stanton and Godwin (1989): 1, 2, 6, 7, 12, 19, 21, 24, 26, 27, 33, 34, 36, 39, 50, 60, 62, 63, 65, 97, 98, 99, 102, 109, 110, 117 Tracey and Webb (
7.3.6rs	Mixed paperbark (Melaleuca quinquenervia and/or M. leucadendra and/or M. dealbata) open forest, often with a well developed understorey of vine forest species, on very wet poorly drained lowlands (palustrine wetland). Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.6x1	Paperbark open forest usually dominated by Melaleuca dealbata (or sometimes leucadendra) and Corymbia tessellaris, usually with a dense understorey of either vine thicket species or Acacia mangium and/or A. crassicarpa, and Lophostemon suaveolens. Moist poorly drained lowlands in areas which form an intricate mosaic with marine sediments and dune material (palustrine wetland).	Kemp et al. (1999): 9, 10.
7.3.7	Swampy coastal lowlands dominated by Eucalytpus tereticornis or E. pellita open forest often with paperbarks (Melaleuca quinquenervia and/or M. leucadendra and/or M. dealbata). Occurs on moist to very wet poorly drained lowlands (palustrine wetland).	Kemp and Morgan (1999): 23, 24, 25 Kemp et al. (1999): 20 Tracey and Webb (1975): 19
7.3.7rs	Swampy coastal lowlands dominated by Eucalytpus tereticornis or E. pellita open forest often with paperbarks (Melaleuca quinquenervia and/or M. leucadendra and/or M. dealbata). Occurs on moist to very wet poorly drained lowlands (palustrine wetland). Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.7x1	Melaleuca sp. aff. viridiflora forest in seasonally inundated shallow drainage lines (palustrine wetland).	Qld Herbarium Townsville 1:250 000 mapsheet (Cumming): 435 (7.3.7x), Kemp, Morgan and Cumming (1999): 22, and Kemp and Morgan (1999):24.
7.3.8	Broad–leaf tea tree (Melaleuca viridiflora) woodland swamp complex on dry to very wet poorly drained lowlands and tablelands.	Kemp and Morgan (1999): 30, 31, 32 Kemp et al. (1999): 21, 22, 23, 24, 31, 32 Stanton and Godwin (1989): 13, 14, 15, 16, 18 Tracey and Webb (1975): 20
7.3.8rs	Broad–leaf tea tree (Melaleuca viridiflora) woodland swamp complex on dry to very wet poorly drained lowlands and tablelands. Regrowth or disturbed vegetation which meets	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.

	the criteria of "remnant vegetation" in the Vegetation Management Act.	

7.3.8x1	Broad–leaf tea tree (Melaleuca viridiflora) or weeping tea-tree (Melaleuca leucadendra) woodland on moist poorly drained lowlands adjacent to mangroves and saltpans. Groundstratum often dominated by Sporobolus virginicus.	Kemp et al. (1999): 7
7.3.9	Red tea tree (Melaleuca dealbata) open forest on moist to dry poorly drained lowlands.	Neldner and Clarkson (1995): 53B
7.3.10	Complex mesophyll vine forest on very wet well drained fertile lowland alluvial soils.	Kemp and Morgan (1999): 26 Stanton and Godwin (1989): 35, 76, 77, 78, 79, 81, 82, 83, 84 Tracey and Webb (1975): 1a
7.3.10ra	Complex mesophyll vine forest on very wet well drained fertile lowland alluvial soils. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.11	Mesophyll vine forest with red stringybark (Eucalyptus pellita) emergents on very wet to wet well drained lowland alluvial soils.	Stanton and Godwin (1989): 52, 53, 54, 64, 108 Tracey and Webb (1975): 13a
7.3.11ra	Mesophyll vine forest with red stringybark (Eucalyptus pellita) emergents on very wet to wet well drained lowland alluvial soils. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.12	Forest red gum (Eucalyptus tereticornis) woodland on very wet to wet well drained lowland alluvial soils.	Kemp and Morgan (1999): 27, 28 Stanton and Godwin (1989): 55 Tracey and Webb (1975): 16g
7.3.12rs	Forest red gum (Eucalyptus tereticornis) woodland on very wet to wet well drained lowland alluvial soils. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.13	Melville Island bloodwood (Corymbia nesophila) woodland on dry well drained lowland gravelly alluvial soils.	Tracey and Webb (1975): 16k
7.3.14	Molloy red box (Eucalyptus leptophleba) woodland on dry well drained upland alluvial soils.	Neldner and Clarkson (1995): 80 Stanton and Godwin (1989): 56, 57 Tracey and Webb (1975): 16h
7.3.15	Darwin stringybark (Eucalyptus tetrodonta) woodland on dry well drained lowland alluvial soils.	Neldner and Clarkson (1995): 94 Tracey and Webb (1975): 16l
7.3.16	Poplar gum (Eucalyptus platyphylla) woodland on dry moderately drained alluvia.	Kemp and Morgan (1999): 33 Kemp et al. (1999): 26, 27, 28, 33 Neldner and Clarkson (1995): 87A Tracey and Webb: 16p, 19
7.3.17	Complex mesophyll vine forest on very wet well drained lowland and foothill piedmont fans.	Kemp and Morgan (1999): 42 Tracey and Webb: 1a

7.3.17ra	Complex mesophyll vine forest on very wet well drained lowland and foothill piedmont fans. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.18	Mesophyll vine forest with pink bloodwood (Corymbia intermedia) emergents on wet to very wet well drained piedmont fans.	Kemp and Morgan (1999): 41 Tracey and Webb: 13a
7.3.18ra	Mesophyll vine forest with pink bloodwood (Corymbia intermedia) emergents on wet to very wet well drained piedmont fans. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.19	Tall open eucalypt forest/woodland complex (Corymbia spp., Eucalyptus spp) on moist piedmont fans.	Kemp and Morgan (1999): 29, 34, 35, 36, 37 Kemp et al. (1999): 25, 29, 30, 34, 35 Tracey and Webb (1975): 19
7.3.20	Pink bloodwood (Corymbia intermedia), turpentine (Syncarpia glomulifera), red stringybark (Eucalyptus pellita) open forest on moist well drained piedmont fans.	Kemp and Morgan (1999): 40 Kemp et al. (1999): 36, 37, 38, 39 Tracey and Webb (1975): 16b
7.3.21	Gympie messmate (Eucalyptus cloeziana) or white mahogany (Eucalyptus acmenoides) open forest on dry well drained piedmont fans.	Kemp and Morgan (1999): 38, 39 Tracey and Webb (1975): 16c
7.3.21a	Eucalyptus platyphylla, Eucalyptus tereticornis, Lophostemon suaveolens, Corymbia clarksoniana, Eucalyptus portuensis, Allocasuarina torulosa, Melaleuca viridiflora, Melaleuca nervosa, Grevillea coriacea	Qld Herbarium North Qld Uveg key (Addicott): ein40-3
7.3.22	Complex mesophyll riparian vine forest on moist and dry well drained lowland alluvial levees.	Kemp and Morgan (1999): 49 Stanton and Godwin (1989): 31, 80 Tracey and Webb (1975): 1c
7.3.22ra	Complex mesophyll riparian vine forest on moist and dry well drained lowland alluvial levees. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.3.23	Notophyll to mesophyll riparian vine forest on dry well drained lowland alluvial levees.	Kemp et al. (1999): 48
7.3.24	Red tea–tree (Melaleuca dealbata) riparian open forest on moist fertile moderately drained lowland alluvia.	Kemp and Morgan (1999): 48 Kemp et al. (1999): 47
7.3.25	Weeping tea–tree (Melaleuca fluviatilis), Melaleuca leucadendra, Moreton Bay ash (Corymbia tessellaris) open forest with notophyll riparian vine forest spp., on levees.	Kemp et al. (1999): 42
7.3.26	River oak (Casuarina cunninghamiana) riparian open forest.	Kemp et al. (1999): 43

7.3.27	Carbeen (Corymbia tessellaris), forest red gum (Eucalyptus tereticornis), swamp mahogany (Lophostemon suaveolens), red tea–tree (Melaleuca dealbata) riparian open forest on levees.	Kemp and Morgan (1999): 45, 46, 47 Kemp et al. (1999): 44, 45, 46
7.3.28	Riparian herbfield/shrubland on river and stream bed alluvia.	Kemp and Morgan (1999): 43, 44 Kemp et al. (1999): 40, 41
7.8.1	Complex mesophyll vine forest on very wet well drained basalt lowlands.	Tracey and Webb (1975): 1a
7.8.1ra	Complex mesophyll vine forest on very wet well drained basalt lowlands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.8.2	Complex mesophyll vine forest on very wet basalt uplands.	Tracey and Webb (1975): 1b
7.8.2ra	Complex mesophyll vine forest on very wet basalt uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.8.3	Complex notophyll vine forest on moist basalt lowlands, foothills and uplands.	Neldner and Clarkson (1995): 4 Tracey and Webb (1975): 5b
7.8.3ra	Complex notophyll vine forest on moist basalt lowlands, foothills and uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.8.4	Complex notophyll vine forest on cloudy wet basalt uplands and highlands.	Tracey and Webb (1975): 5a
7.8.4ra	Complex notophyll vine forest on cloudy wet basalt uplands and highlands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.8.5	Notophyll vine forest dominated by blackwood (Acacia melanoxylon) ? brown salwood (Acacia celsa) on cloudy wet basalt uplands and highlands.	Tracey and Webb (1975): 12d
7.8.6	Semi–deciduous mesophyll vine forest on moist basalt foothills.	Stanton and Godwin (1989): 86 Tracey and Webb (1975): 4
7.8.7	Forest red gum (Eucalyptus tereticornis) tall open forest on moist basalt uplands and highlands.	Tracey and Webb (1975): 14c
7.8.7x1	Eucalyptus grandis, Corymbia intermedia, Acacia melanoxylon and Lophostemon confertus open forest and woodland, or vine forest with emergent E. grandis, Acacia melanoxylon and A. celsa. May include areas of E. resinifera. Slopes underlain by basalt.	Tracey and Webb (1975): 13c and 14a, Harrington and Sanderson (1994): t4.
7.8.8	White stringybark (Eucalyptus phaeotricha)	Tracey and Webb (1975): 16n

	woodland on moist basalt uplands and highlands.	

7.8.9	Molloy red box (Eucalyptus leptophleba) woodland on dry basalt uplands.	Neldner and Clarkson (1995): 79 Tracey and Webb (1975): 16h
7.8.10	Forest red gum (Eucalyptus tereticornis) woodland on dry basalt uplands and highlands.	Tracey and Webb (1975): 16o
7.8.10rs	Forest red gum (Eucalyptus tereticornis) woodland on dry basalt uplands and highlands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.1	Mesophyll vine forest on very wet to wet metamorphic lowlands and foothills.	Tracey and Webb (1975): 2a Neldner and Clarkson (1995): 3
7.11.1ra	Mesophyll vine forest on very wet to wet metamorphic lowlands and foothills. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.2	Mesophyll fan palm (Licuala ramsayi) swamp vine forest on very wet poorly drained metamorphic foothills and tablelands.	Tracey and Webb (1975): 3b
7.11.2ra	Mesophyll fan palm (Licuala ramsayi) swamp vine forest on very wet poorly drained metamorphic foothills and tablelands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.2x1	This should ideally be a new Wet tropics Land Zone 7 RE, however there are no Land Zone 7 REs in which to place it. Mesophyll vine forest, with some areas including Acacia mangium and Acacia aulacocarpa, and some with fan palms (Licuala ramsayi). Tertiary duricrust.	Tracey and Webb (1975): 2a, 3b, 12c.
7.11.3	Semi–deciduous mesophyll vine forest on moist metamorphic foothill slopes.	Neldner and Clarkson (1995): 7, 8 Tracey and Webb (1975): 4
7.11.4	Mesophyll vine forest dominated by brown salwood (Acacia celsa) on very wet to wet metamorphic lowlands and foothills.	Tracey and Webb (1975): 12c
7.11.4ra	Mesophyll vine forest dominated by brown salwood (Acacia celsa) on very wet to wet metamorphic lowlands and foothills. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.5	Simple mesophyll vine forest with red stringybark (Eucalyptus pellita) emergents on very wet to wet metamorphic lowlands and foothills.	Neldner and Clarkson (1995): 42 Tracey and Webb (1975): 13a
7.11.5ra	Simple mesophyll vine forest with red stringybark (Eucalyptus pellita) emergents on very wet to wet metamorphic lowlands and foothills. Regrowth or disturbed vegetation	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.

	which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	

7.11.6	Simple mesophyll vine forest with turpentine (Syncarpia glomulifera) emergents on very wet to wet metamorphic lowlands and foothills.	Stanton and Godwin (1989): 70 Tracey and Webb (1975): 13e
7.11.6ra	Simple mesophyll vine forest with turpentine (Syncarpia glomulifera) emergents on very wet to wet metamorphic lowlands and foothills. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.7	Complex notophyll vine forest with kauri pine (Agathis robusta) emergents on moist metamorphic foothills and uplands.	Neldner and Clarkson (1995): 5 Tracey and Webb (1975): 6
7.11.7ra	Complex notophyll vine forest with kauri pine (Agathis robusta) emergents on moist metamorphic foothills and uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.8	Notophyll vine forest with acacia (Acacia spp.) emergents on moist metamorphic lowlands and foothills.	Tracey and Webb (1975): 7a
7.11.9	Notophyll semi–evergreen vine forest on moist to dry metamorphic foothills and uplands.	Olsen: 27
7.11.10	Notophyll vine forest dominated by brown salwood (Acacia celsa) on very wet to wet metamorphic foothills, uplands and highland ridges.	Neldner and Clarkson (1995): 26 Tracey and Webb (1975): 12a
7.11.10ra	Notophyll vine forest dominated by brown salwood (Acacia celsa) on very wet to wet metamorphic foothills, uplands and highland ridges. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.11	Notophyll vine forest dominated by Acacia cincinnata/Acacia polystachya on wet metamorphic foothills and uplands.	Neldner and Clarkson (1995): 26 Tracey and Webb (1975): 12b
7.11.12	Simple notophyll vine forest on cloudy wet metamorphic uplands.	Tracey and Webb (1975): 8
7.11.13	Simple notophyll vine forest with forest red gum (Eucalyptus tereticornis) emergents on moist metamorphic foothills and uplands.	Tracey and Webb (1975): 13b
7.11.13ra	Simple notophyll vine forest with forest red gum (Eucalyptus tereticornis) emergents on moist metamorphic foothills and uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.14	Simple notophyll vine forest with rose gum (Eucalyptus grandis) emergents on moist metamorphic uplands.	Tracey and Webb (1975): 13c

7.11.15	Simple notophyll vine forest dominated by blackwood (Acacia melanoxylon) brown salwood (Acacia celsa) on cloudy wet metamorphic uplands and highlands.	Tracey and Webb (1975): 12d
7.11.16	Tall open pink bloodwood (Corymbia intermedia) woodland on moist metamorphic uplands.	Tracey and Webb (1975): 14d
7.11.16x1	Eucalyptus portuensis (often the sole canopy species), E. crebra, Corymbia clarksoniana, C. intermedia, C. citriodora, Lophostemon suaveolens, Melaleuca viridiflora, Acacia flavescens and Allocasuarina littoralis open forest. Some areas may be dominated by C. citriodora. Hillslopes formed from metamorphosed sediments.	Stanton and Stanton (in prep.): M16m, M16i, M21b.
7.11.16x1 rs	Eucalyptus portuensis (often the sole canopy species), E. crebra, Corymbia clarksoniana, C. intermedia, C. citriodora, Lophostemon suaveolens, Melaleuca viridiflora, Acacia flavescens and Allocasuarina littoralis open forest. Some areas may be dominated by C. citriodora. Hillslopes formed from metamorphosed sediments. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.16x2	Eucalyptus reducta open forest to woodland, sometimes with Corymbia intermedia and Syncarpia glomulifera. Hillslopes formed from metamorphosed sediments.	Stanton and Stanton (in prep.): M16s, M30.
7.11.17	Red stringybark (Eucalyptus pellita) woodland of the wet to moist metamorphic lowlands and foothills.	Stanton and Godwin (1989): 61 Tracey and Webb (1975): 16b
7.11.17rs	Red stringybark (Eucalyptus pellita) woodland of the wet to moist metamorphic lowlands and foothills. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.18	Forest red gum (Eucalyptus tereticornis) woodland on wet to moist metamorphic foothills.	Neldner and Clarkson (1995): 44 Tracey and Webb (1975): 16a
7.11.18rs	Forest red gum (Eucalyptus tereticornis) woodland on wet to moist metamorphic foothills. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.19	Pink bloodwood (Corymbia intermedia) woodland on moist to dry metamorphic foothills and uplands.	Neldner and Clarkson (1995): 40 Tracey and Webb (1975): 16e

7.11.19rs	Pink bloodwood (Corymbia intermedia) woodland on moist to dry metamorphic foothills and uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.20	Melville Island bloodwood (Corymbia nesophila) forest on dry metamorphic lowlands and foothills.	Neldner and Clarkson (1995): 41, 46 Tracey and Webb (1975): 16k
7.11.21	Molloy red box (Eucalyptus leptophleba) woodland on dry metamorphic uplands.	Neldner and Clarkson (1995): 43, 81 Tracey and Webb (1975): 16h
7.11.21rs	Molloy red box (Eucalyptus leptophleba) woodland on dry metamorphic uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.11.22	Cullen's ironbark (Eucalyptus cullenii) woodland on dry metamorphic ridgetops.	Neldner and Clarkson (1995): 39 Tracey and Webb (1975): 16j
7.12.1	Mesophyll vine forest on very wet to wet granite lowlands and foothills.	Neldner and Clarkson (1995): 3 Tracey and Webb (1975): 2a
7.12.1ra	Mesophyll vine forest on very wet to wet granite lowlands and foothills. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.2	Fan palm (Licuala ramsayi) dominated mesophyll vine forest on very wet poorly drained granite foothills.	Tracey and Webb (1975): 3b
7.12.3	Mesophyll vine forest with forest red gum (Eucalyptus tereticornis) emergents on wet to moist granite foothills.	Tracey and Webb (1975): 13d
7.12.4	Mesophyll vine forest with turpentine (Syncarpia glomulifera) emergents on very wet granite and rhyolite lowlands and foothills.	Stanton and Godwin (1989): 70 Tracey and Webb (1975): 13e
7.12.5	Simple mesophyll vine forest with red stringybark (Eucalyptus pellita) emergents on very wet to wet granite lowlands and foothills.	Neldner and Clarkson (1995): 42 Tracey and Webb (1975): 13a
7.12.5ra	Simple mesophyll vine forest with red stringybark (Eucalyptus pellita) emergents on very wet to wet granite lowlands and foothills. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.6	Semi–deciduous mesophyll vine forest on moist granite lowlands and foothills.	Neldner and Clarkson (1995): 6 Stanton and Godwin (1989): 86 Tracey and Webb (1975): 4
7.12.7	Complex notophyll vine forest with emergent kauri pine (Agathis robusta) on moist granite foothills and uplands.	Tracey and Webb (1975): 6

7.12.7ra	Complex notophyll vine forest with emergent kauri pine (Agathis robusta) on moist granite foothills and uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.8	Complex notophyll vine forest with emergent bunya pine (Araucaria bidwilli) on moist granite uplands on yellow podzolic soils.	Tracey and Webb (1975): 6
7.12.8ra	Complex notophyll vine forest with emergent bunya pine (Araucaria bidwilli) on moist granite uplands on yellow podzolic soils. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.9	Notophyll/mesophyll vine forest dominated by brown salwood (Acacia celsa) on very wet to wet granite foothills and uplands.	Tracey and Webb (1975): 12a
7.12.9ra	Notophyll/mesophyll vine forest dominated by brown salwood (Acacia celsa) on very wet to wet granite foothills and uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.10	Notophyll vine forest with emergent hoop pine (Araucaria cunninghamii) on moist granite foothills and uplands.	Olsen: 25
7.12.11	Notophyll semi–evergreen vine forest on moist to dry granite foothills and uplands.	Olsen: 27
7.12.12	Notophyll vine forest with acacia (Acacia spp.) emergents on moist granite lowlands and foothills.	Tracey and Webb (1975): 7a
7.12.13	Notophyll vine forest dominated by blackwood (Acacia melanoxylon) on cloudy wet granite and rhyolite uplands and highlands.	Tracey and Webb (1975): 12d
7.12.14	Notophyll vine forest with rose gum (Eucalyptus grandis) emergents on cloudy wet granite and rhyolite upland ridges.	Tracey and Webb (1975): 13c
7.12.14a	Tall forest with Eucalyptus grandis, Syncarpia glomulifera, E. intermedia +/- E. resinifera +/- Casuarina torulosa. Notophyll vine midstratum or subcanopy. Undulating low hilly areas.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 500
7.12.14b	Tall forest with Eucalyptus grandis as emergents in notophyll vine forest	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 511
7.12.15	Notophyll vine forest with turpentine (Syncarpia glomulifera) emergents on wet to moist granite uplands and highlands.	Tracey and Webb (1975): 13f
7.12.16	Simple notophyll vine forest on cloudy wet granite and rhyolite uplands and highlands.	Neldner and Clarkson (1995): 23 Tracey and Webb (1975): 8
7.12.16b	Notophyll vine forest. (Fine-textured forest on hilltops looks very different from typical	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 512

	rainforest)	

7.12.17	Simple notophyll vine forest with cadaghi (Corymbia torelliana) emergents on moist granite and rhyolite foothills and uplands.	Tracey and Webb (1975): 13b
7.12.18	Microphyll vine forest often with hoop pine (Araucaria cunninghamii) on moist to dry granite foothills and uplands.	Olsen: 26
7.12.19	Simple microphyll vine forest on cloudy wet granite highlands.	Neldner and Clarkson (1995): 28 Tracey and Webb (1975): 9
7.12.19ra	Simple microphyll vine forest on cloudy wet granite highlands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.20	Low microphyll vine forest on cloudy wet windswept granite highlands.	Neldner and Clarkson (1995): 30 Tracey and Webb (1975): 10
7.12.21	Tall open rose gum (Eucalyptus grandis) forest on cloudy moist granite and rhyolite uplands and highlands.	Tracey and Webb (1975): 14a
7.12.22	Tall open red mahogany (Eucalyptus resinifera) forest on moist granite and rhyolite uplands and highlands.	Tracey and Webb (1975): 14b
7.12.23	Tall open pink bloodwood (Corymbia intermedia) woodland on moist granite and rhyolite uplands.	Tracey and Webb (1975): 14d
7.12.23b	Forest with Eucalyptus intermedia, Syncarpia glomulifera, Eucalyptus portuensis and Casuarina torulosa. Low hilly to hilly.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 345
7.12.24	White mahogany (Eucalyptus acmenoides) woodland on wet to moist granite foothills.	Stanton and Godwin (1989): 74 Tracey and Webb (1975): 15b
7.12.24x1	Eucalyptus leptophleba, Corymbia clarksoniana, E. platyphylla, C. dallachiana, C. tessellaris, E. tereticornis, Erythrophleum chlorostachys, Lophostemon grandiflorus, Melaleuca viridiflora, M. minutiflora, Allocasuarina littoralis and Allocasuarina leuhmanii. Hillslopes formed from acid volcanics.	Tracey and Webb (1975): 16h, and Stanton and Stanton (in prep.): G16h, G34, G40, G49.
7.12.25	Gympie messmate (Eucalyptus cloeziana) woodland on wet to moist granite uplands.	Neldner and Clarkson (1995): 38 Tracey and Webb (1975): 16c
7.12.25x1	Eucalyptus cloeziana open forest, often with Corymbia intermedia, Syncarpia glomulifera and Allocasuarina torulosa. Hillslopes formed from acid volcanics.	Cumming (1995): 6, and Cumming and Thomas (1993): 8.
7.12.26	Turpentine (Syncarpia glomulifera) woodland on moist granite uplands.	Tracey and Webb (1975): 16f
7.12.27	White stringybark (Eucalyptus phaeotricha) woodland on moist granite and rhyolite uplands and highlands.	Tracey and Webb (1975): 16n
7.12.28	Poplar gum (Eucalyptus platyphylla) woodland on moist granite lowlands and foothills.	Stanton and Godwin (1989): 59, 73 Tracey and Webb (1975): 16p

7.12.29	Pink bloodwood (Corymbia intermedia) woodland on moist to dry granite foothills and uplands.	Tracey and Webb (1975): 16e

7.12.29rs	Pink bloodwood (Corymbia intermedia) woodland on moist to dry granite foothills and uplands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.30	Lemon–scented gum (Corymbia citriodora) woodland on moist to dry granite uplands and highlands.	Tracey and Webb (1975): 16i
7.12.31	White mahogany (Eucalyptus acmenoides) ? poplar gum (Eucalyptus platyphylla) woodland on dry granite foothill slopes.	Tracey and Webb (1975): 16d
7.12.31x1	Eucalyptus portuensis, Corymbia peltata, E. drepanophylla, E. shirleyi and Lophostemon confertus woodland. Hillslopes formed from acid volcanics.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 503 (7.12.31x).
7.12.32	Cullen's ironbark (Eucalyptus cullenii) woodland on dry granite ridgetops.	Neldner and Clarkson (1995): 70 Tracey and Webb (1975): 16j
7.12.33	Melville Island bloodwood (Corymbia nesophila) woodland on dry granite slopes.	Neldner and Clarkson (1995): 82 Tracey and Webb (1975): 16k
7.12.34	White mahogany (Eucalyptus acmenoides) woodland on dry granite uplands and highlands.	Tracey and Webb (1975): 16 m
7.12.34rs	White mahogany (Eucalyptus acmenoides) woodland on dry granite uplands and highlands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.35	Forest red gum (Eucalyptus tereticornis) woodland on dry granite uplands and highlands.	Tracey and Webb (1975): 16o
7.12.35rs	Forest red gum (Eucalyptus tereticornis) woodland on dry granite uplands and highlands. Regrowth or disturbed vegetation which meets the criteria of "remnant vegetation" in the Vegetation Management Act.	Combination of Stanton and Stanton (in prep) coding and sources listed for the root RE.
7.12.36	Deciduous microphyll vine thicket on fire protected dry granite lowlands.	Tracey and Webb (1975): 11
7.12.37	Mountain rock pavement herbland on cloudy wet granite uplands and highlands.	Neldner and Clarkson (1995): 189 Tracey and Webb (1975): 21
7.12.38	Boulderfield alga land on moist to wet granodiorite foothills.	Neldner and Clarkson (1995): 195 Tracey and Webb (1975): 21, 11
9.3.1	Woodland of Eucalyptus camaldulensis, Casuarina cunninghamiana, &/or Melaleuca fluviatilis +/- scattered mid layer of Lophostemon grandiflorus &/or M. bracteata &/or M. linariifolia. River channels.	Qld Herbarium North Qld Uveg key (Addicott): eiu54-3
9.3.1b	Forest of Eucalyptus tereticornis with Lophostemon suaveolens, dense mid-layer of Acacia aulacocarpa, with occasional Buckinghamia celsissima and other notophyll	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 4rr-3

	vine forest species. Riverine.	

9.3.1e	Tall woodland to open woodland of Eucalyptus tereticornis +/- Casuarina cunninghamiana &/or Eucalyptus tessellaris +/- a midlayer of Callistemon viminalis dominating. Large river channels generally surrounded by well developed alluvial deposits.	Qld Herbarium North Qld Uveg key (Addicott): eiu60-3
9.3.1c	Forest or woodland with Eucalyptus camaldulensis &/or E. tereticornis, Melaleuca fluviatilis +/- M. leucadendra +/- Casuarina cunninghamiana +/- Lophostemon grandiflorus +/- Melaleuca viminalis +/- M. linariifolia +/- Pleiogynium timorense +/- Nauclea orientalis +/- Cryptostegia grandiflora. Corymbia tessellaris +/- E. platyphylla on higher banks. Riverine situations along minor to major creeks - alluvium derived from granite.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 2.
9.3.2	Tall woodland to open woodland of Eucalyptus leptophleba &/or Corymbia dallachiana +/- Eucalyptus crebra (sens. lat.) or Eucalyptus cullenii &/or Eucalyptus persistens &/or Eucalyptus platyphylla with no to shrubby mid layer of Melaleuca viridiflora and a grassy ground layer.	Qld Herbarium North Qld Uveg key (Addicott): ein28-3
9.3.5	Tall woodland to open woodland of Eucalyptus brownii +/- Eucalyptus platyphylla. Well developed alluvial deposits and levees.	Qld Herbarium North Qld Uveg key (Addicott): ein12-3
9.5.5c	Open forest to woodland of Corymbia citriodora, Eucalyptus crebra (sens. lat.) +/- Eucalyptus portuensis &/or Eucalyptus tereticornis &/or Corymbia intermedia with shrub land mid layer of Lophostemon suaveolens &/or Acacia flavescens &/or Grevillea parallela &/or Allocasuarina inophloia. On fine red soils on tertiary surfaces, usually on upperslopes and crests.	Qld Herbarium North Qld Uveg key (Addicott): 39-5
9.5.5z	Tall woodland of Corymbia citriodora and Eucalyptus crebra (occasionally without C. citriodora). Very grassy ground layer of Bothriochloa spp. or Heteropogon contortus. Low tertiary rises with obvious red or mottled soils.	Qld Herbarium Ingham 1:250 000 mapsheet (2001). (Einasleigh and Wet Tropics edge only) (Pollock): ap2-5.
9.5.5x3	This should ideally be a new Wet Tropics RE, however there are no Land Zone 5 Res in the Wet Tropics in which to place it. Eucalyptus portuensis, +/- Corymbia intermedia, and/or C. clarksoniana, and/or Eucalyptus tereticornis, and/or Lophostemon suaveolens open forest to woodland with a mid layer of isolated shrubs to shrubland of Acacia flavescens, Allocasuarina torulosa and a grassy ground layer. Undulating	Qld Herbarium Ingham 1:250 000 mapsheet (2001). (Einasleigh and Wet Tropics edge only) (Pollock): ein41-5.

	areas and plateaus on tertiary sands.	

9.7.1x1	Woodland of Eucalyptus shirleyi &/or Corymbia peltata +/- Eucalyptus persistens &/or Eucalyptus setosa &/or Eucalyptus crebra (sens. lat.) with no mid layer to a shrub layer of Acacia shirleyi. Hill slopes and edges of ridge lines and plateaux on laterised granites.	Qld Herbarium North Qld Uveg key (Addicott): ein51-7
9.7.3a	Woodland of Eucalyptus crebra (sens. lat.) Eucalyptus howittiana &/or Corymbia citriodora &/or Corymbia clarksoniana &/or Eucalyptus persistens with a dense shrub layer of Allocasuarina torulosa, Allocasuarina inophloia or Acacia decora, Jacksonia thesioides and a very sparse grassy ground layer. Granite breakaways and rolling hills on edge of tertiary tablelands.	Qld Herbarium North Qld Uveg key (Addicott): ein26-7
9.8.1a	Woodland of Eucalyptus crebra +/- Corymbia erythrophloia &/or Corymbia dallachiana with no mid layer to an open shrub land of Grevillea glauca &/or Grevillea parallela or softwood species and dense grassy ground layer. Lava plains, sheet basalts.	Qld Herbarium North Qld Uveg key (Addicott): ein25-8
9.8.1x7	Grassland to very open grassy woodland with Corymbia tessellaris, C. dallachiana and Pleiogynium timorense. Steep basalt knolls Tb - rocky basalt, not cracking clay.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming):190 (9.8.1x4).
9.8.2	Eucalyptus leptophleba, Corymbia clarksoniana, Eucalyptus cullenii, Eucalyptus tereticornis.	Qld Herbarium North Qld Uveg key (Addicott): ath4-8
9.8.4a	Tall woodland of Eucalyptus crebra (sens. lat.), Eucalyptus tereticornis +/- Corymbia clarksoniana (in eastern localities). Basalt flows on gentle slopes or occasionally valley flats.	Qld Herbarium North Qld Uveg key (Addicott): ein8-8
9.8.4b	Eucalyptus moluccana +/- Eucalyptus crebra (sens. lat.) &/or Eucalyptus platyphylla &/or Corymbia clarksoniana with no mid layer and a grassy ground layer. Slightly weathered basalts.	Qld Herbarium North Qld Uveg key (Addicott): ein13-a
9.10.1x5	Woodland with Corymbia trachyphloia (sometimes as mallee), Eucalyptus portuensis and occasional Corymbia citriodora. Midstratum shrubby, with Acacia calyculata, Daviesia flava, Pultenaea petiolaris and others. Minor scarps and edge of red soil plateaus.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 314-7
9.11.2a	Woodland with Eucalyptus drepanophylla (or E. crebra sens. lat.), Corymbia dallachiana, +/- C. erythrophloia and C. clarksoniana. Steep hills.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 379
9.11.2e	Mid-high to tall woodland of Eucalyptus crebra (sens. lat.), Corymbia clarksoniana, +/- Corymbia dallachiana, Eucalyptus platyphylla,	Qld Herbarium North Qld Uveg key (Addicott): ein2br-11

	no mid layer and grassy ground layer. Undulating rises generally surrounded by alluvium or river system.	

9.11.3	Eucalyptus cullenii + E. clarksoniana (Acid volcanic ranges).	Qld Herbarium Cooktown 1:250 000 mapsheet (in prep.): 70
9.11.4	Corymbia citriodora, Eucalyptus drepanophylla, E. acmenoides and E. cloeziana open forest on skeletal soils on hills on sedimentary and metamorphic rocks.	Sattler and Williams (1999).
9.11.4a	Tall open forest to woodland of Eucalyptus crebra (sens. lat.), Corymbia citriodora +/- Corymbia clarksoniana &/or Eucalyptus portuensis &/or Eucalyptus tereticornis &/or Corymbia intermedia with a mid layer shrub layer of Acacia flavescens, Grevillea glauca, Petalostigma pubescens and a grassy ground layer. Dissected hills on western edge of Tertiary plateaux.	Qld Herbarium North Qld Uveg key (Addicott): ein65-11
9.11.5x4	Woodland mosaic of Eucalyptus persistens and E. melanophloia +/- E. crebra +/- Grevillea aff. parallela. Mid-stratum moderate, with Acacia gonoclada and Erythroxylum australe. Gentle hills.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 11
9.11.7	Woodland to open forest of Eucalyptus platyphylla +/- E. clarksoniana (Flat wet plains).	Qld Herbarium North Qld Uveg key (Addicott): cyp87, ein7-3.
9.12.1x10	Woodland with Eucalyptus drepanophylla or E. crebra or E. crebra/drepanophylla, Corymbia erythrophloia and C. dallachiana. Minor flats with E. platyphylla. Gently undulating hills.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 209-12
9.12.1x13	Open woodland with E. drepanophylla. Corymbia dallachiana, E. platyphylla +/- Corymbia erythrophloia +/- Eucalyptus portuensis +/- Corymbia tessellaris. Midstratum mid-dense, with Acacia flavescens, Planchonia careya, Bursaria incana +/- Cochlospermum gillvraei +/- Grevillea parallela +/- Xylomelum scottianum + Erythrina vespertilio. Hills and escarpments.	Qld Herbarium North Qld Uveg key (Addicott): GWW63
9.12.2	Tall woodland of Corymbia citriodora, Eucalyptus crebra (sens. lat.) (or E.granitica), Corymbia clarksoniana +/- Eucalyptus howittiana with a dense shrub layer of Acacia decora, Jacksonia thesioides, Allocasuarina inophloia and a very sparse ground layer. Edges of low Tertiary soil plateaux.	Qld Herbarium North Qld Uveg key (Addicott): ein38-12
9.12.2d	Woodland with Eucalyptus granitica, Corymbia citriodora, Eucalyptus portuensis, Corymbia intermedia +/- E. tereticornis +/- Syncarpia glomulifera +/- C. peltata +/- E. shirleyi +/- E. drepanophylla or E. crebra. Mid-dense midstratum of Melaleuca viridiflora +/- Acacia flavescens +/- A. calyculata. Ground layer of	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 374-12

	Themeda triandra. Low hilly to steep slopes.	

9.12.2e	Open forest to woodland of Eucalyptus portuensis +/- Corymbia intermedia &/or Corymbia clarksoniana &/or Eucalyptus tereticornis &/or Lophostemon suaveolens with a mid layer of isolated shrubs and a grassy ground layer. High dissected ranges.	Qld Herbarium Ingham 1:250 000 mapsheet (2001). (Einasleigh and Wet Tropics edge only) (Pollock): ein41-12
9.12.2x3	Woodland with Eucalyptus aff. crebra, E. shirleyi, E. portuensis, E. exserta, Corymbia citriodora, C. leichhardtii +/- C. clarksoniana. Midstratum moderate +/- Melaleuca viridiflora +/- Melaleuca nervosa +/- Grevillea glauca +/- Petalostigma pubescens +/- Bursaria incana +/- Xylomelum scottianum.	Qld Herbarium North Qld Uveg key (Addicott): tvl494
9.12.2x6	Woodland with Eucalyptus granitica, Corymbia abergiana, E. portuensis, C. leichhardtii, E. exserta +/- E. shirleyi +/- C. citriodora +/- Syncarpia glomulifera +/- Lysicarpus angustifolius. Hilly granite massifs.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 341-12
9.12.2x8	Open woodland of Corymbia leichhardtii, C. lamprophylla, Araucaria cunninghamii, Pleiogynium timorense, Cochlospermum gillivraei and Lophostemon grandiflorus. Midstratum of Acacia leptostachya. Rugged hills.	Qld Herbarium North Qld Uveg key (Addicott): tvl49-12.
9.12.2x12	Woodland on low rises with Corymbia citriodora, Eucalyptus acmenoides, Eucalyptus drepanophylla or E. crebra (or woodland of E. molluccana and E. crebra) and grassy ground layer. Low hilly landscape.	Qld Herbarium Townsville 1:250 000 mapsheet (2000), (Cumming): 275c-12, 275m-12
9.12.2x13	Tall open forest to woodland of Eucalyptus tereticornis +/- Corymbia intermedia &/or Corymbia tessellaris &/or Corymbia clarksoniana with a dense shrub layer of Lophostemon suaveolens &/or Eucalyptus platyphylla &/or Bursaria incana &/or Alphitonia excelsa &/or Petalostigma pubescens &/or Melaleuca viridiflora and no ground layer. Low undulating hills.	Qld Herbarium North Qld Uveg key (Addicott): ein37-12

Additional unit:

9999	This code is used where none of the coverages used in the mapping were able to provide a vegetation unit. It mostly corresponds to areas where the Tracey 1975 mapping was mapped as cleared but the Qld Herbarium 1999 remnant coverage (used to update the coverage to 1999) was mapped as remnant. It is probable that most of these polygons have never been cleared and the discrepancy between the two coverages is due to the scale difference (approx. 1:250,000 for Tracey as opposed to 1:50,000 for the Qld Herbarium landcover).

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Appendix B

Spreadsheets for the three model multiple criteria analysis

MULTIPLE CRITERIA /MULTIPLE ATTRIBUTE ANALYSIS OF ECOSYSTEM GOODS AND SERVICES

THE ANTHROPOCENTIC PERSPECTIVE/PARADIGM

CRITERIA	Max Weight
A: Essential to human life	6
B: Essential component of ecosystem health	4
C: Essential for maintenance of natural capital	2
D: Desirable but not essential for human well-being	5
E: Desirable but not essential for ecosystem health	3
F: Desirable but not essential for maintenance of natural capital	1

INSTRUCTIONS

Instructions: Decide which criterion relates to which attribute of an ecosystem and assign a weight, it does not have to be the maximum weight allocated, but should reflect what you feel to be the relative importance of that ecosystem service to the planet's overall life support system. Enter the weighting you choose in the appropriate cell, eg. water regulation: Criteria: B, weight: 3.

See NB below the matrix

Group & Attribute	Criteria					
	A	B	C	D	E	F
Stabilisation Services						
Gas regulation (atmospheric composition)						
Climate regulation (temperature, rainfall)						
Disturbance regulation (ecosystem resilience)						
Water regulation (hydrological cycle)		3				
Erosion control and soil/sediment retention						
Biological control (populations, pest/disease control)						
Refugia (habitats for resident and transient populations)						
Regeneration Services						
Soil formation						
Nutrient cycling and storage (including carbon)						
Assimilation of waste and attenuation, detoxification						
Purification (clean water, air)						
Pollination (movement of floral gametes)						
Biodiversity						
Production of Goods						
Water supply (catchment)						
Food production (that sustainable portion of GPP)						
Raw materials (that sustainable portion of GPP)						
Genetic resources (medicines, scientific resources)						
Life Fulfilling Services						
Recreation opportunities (nature-based tourism)						
Aesthetic, cultural and spiritual, (existence values)						
Other non-use values (bequest & quasi option values)						

NB: The choices are mutually exclusive, ie. if you pick criteria A for an attribute, you cannot put a value in the cell for criteria D, a choice cannot be 'Essential for etc.', and at the same time be 'Desirable but not essential for etc.' So for each row/attribute ONLY three cells will have a value in them. Note: GPP stands for Gross Primary Production.

MULTIPLE CRITERIA /MULTIPLE ATTRIBUTE ANALYSIS OF ECOSYSTEM GOODS AND SERVICES

MODEL 2. UTILITARIAN PARADIGM/PERSPECTIVE

CRITERIA		Max Weight
Direct Use Value	The value ascribed to actual use of an attribute, eg drinking water	6
Indirect Use Value	The value ascribed to the intangible benefits derived from a service	4
Option Use Value	The value of knowing that the actual use of an attribute is available	2
Option Non-Use Value	The value of knowing that the benefits of a service are available	5
Bequest Non-Use Value	The value of knowing that attributes are preserved for future people	3
Existence Non-Use Value	The value of knowing that an attribute exists, even though an individual may never use/see it	1

Instructions: Select which criteria apply to which attribute and assign the weight (importance) using the maximum weights shown for the criteria. You can assign less than the max weight for the criteria, but not more. Some attributes will have a value in 3 or more columns. For eg. Gas regulation: Use Value: indirect = 4, option = 2
Non-use Value: all ie 5, 3, 1.
Or water supply: Use value: Direct and option: 6, 2.
Non-use Value: Bequest = 3

Group	Type		Use Value			Non-Use Value		
			Direct	Indirect	Option	Option	Bequest	Existence
Stabilisation Services	Gas regulation (atmospheric composition)			4	2	5	3	1
	Climate regulation (temperature, rainfall)							
	Disturbance regulation (ecosystem resilience)							
	Water regulation (hydrological cycle)							
	Erosion control and soil/sediment retention							
	Biological control (populations, pest/disease control)							
	Refugia (habitats for resident and transient populations)							
Regeneration Services	Soil formation							
	Nutrient cycling and storage (incl carbon sequestration)							
	Assimilation of waste and attenuation, detoxification							
	Purification (clean water, air)							
	Pollination (movement of floral gametes)							
	Biodiversity							
Production of Goods	Water supply (catchment)		6		2		3	
	Food production (that sustainable portion of GPP)							
	Raw materials (that sustainable portion of GPP, timber, fibre etc.)							
	Genetic resources (medicines, scientific and technological resources							
Life Fulfilling Services	Recreation opportunities (nature-based tourism)							
	Aesthetic, cultural and spiritual, (existence values)							
	Other non-use values (bequest and quasi option values)							

MULTIPLE CRITERIA /MULTIPLE ATTRIBUTE ANALYSIS OF ECOSYSTEM GOODS AND SERVICES

MODEL 3. 'BALANCED' SENSITIVITY PARADIGM/PERSPECTIVE

Instructions: For each attribute consider the sensitivity criteria and either award the maximum weight for that criteria, or less if you think the threat, risk etc is less than the maximum, obviously some attributes are under more threat etc than others, eg biodiversity. Then decide what level of resistance and resilience each attribute has and award a weight accordingly, ie 7.5 or less. See the webpage for definitions. Examples below: Water Reg: low threat/risk, zero uncertainty, need for precaution, both high resistence and high resilience. Refugia: max threat/risk/etc, low resistence, moderate to high resilience.

SENSITIVITY CRITERIA	Max Weight
Threats	-4
Risk	-3
Uncertainty	-2
Precaution	-1
Resistance	7.5
Resilience	7.5

Group	Type	Ecosystem Sustainability					
		Threats	Risk	Uncertainty	Precaution	Resistence	Resilience
Stabilisation Services	Gas regulation (atmospheric composition)						
	Climate regulation (temperature, rainfall)						
	Disturbance regulation (ecosystem resilience)						
	Water regulation (hydrological cycle)	-1	-1	0	-1	6	7
	Erosion control and soil/sediment retention						
	Biological control (populations, pest/disease control)						
	Refugia (habitats for resident and transient populations)	-4	-3	-2	-1	2	5
Regeneration Services	Soil formation						
	Nutrient cycling and storage (incl carbon sequestration)						
	Assimilation of waste and attenuation, detoxification						
	Purification (clean water, air)						
	Pollination (movement of floral gametes)						
	Biodiversity						
Production of Goods	Water supply (catchment)						
	Food production (that sustainable portion of GPP)						
	Raw materials (that sustainable portion of GPP, timber, fibre etc.)						
	Genetic resources (medicines, scientific and technological resources						
Life Fulfilling Services	Recreation opportunities (nature-based tourism)						
	Aesthetic, cultural and spiritual, (existence values)						
	Other non-use values (bequest, option and quasi option values)						

Appendix C

Introduction to the Delphi Inquiry. The Delphi Panel. First round preamble and questionnaire

NB. The HTML file for this first round introduction of the Delphi is no longer available electronically, only in hard copy, accordingly this word file is a verbatim copy of the web page accessed and printed June 4, 2002 that is included in the thesis.

Greetings, and welcome to the first round of the Delphi.

You are a group of 50 scientists and economists from government, NGOs, advanced educational institutions and the private sector. The commonality of the group is their expressed interest in this topic. Some participants are more 'expert' than others, however as our ideas and experiences are highly idiosyncratic, in the context of a Delphi panel individual panellists may view the group in different ways, independent of the topic. It is important that the group does not tend to divert energy from the task of defining a shared reality relative to the topic, to defining the reality of the group relationship and the meaning of its findings. As individual conceptualisation of the nature of the group will affect the quality of the interaction and the final product, I will profile some participants without nominating them during the course of the interaction, and provide feedback relative to responses from the various categories of panellists.

The second round of the Delphi will include feedback from the first round, an opportunity to revise or vary responses, a theoretical justification of the surrogate market approach, and the first model (weighting ecosystem attributes), that is called the anthropocentric perspective/paradigm. The third round will provide feedback and present the second model (the utilitarian perspective/paradigm). The fourth round will seek to arrive at a balanced weighting of sensitivities including ecosystem resistance and resilience, threats, risk, uncertainty and precaution. The fifth round will present some results of statistical analysis of the data and offer an opportunity to revise or vary responses. The sixth round will present final results of the Delphi process and whether or not the group reached consensus.

But first a few more words about the Delphi technique. A set of statements/questions that pretend to describe some alleged truth need to be validated by one of the philosophical systems/modes also called an inquiring system (IS), ie. the statement/question must embody the major philosophical criterion to be met. There are many philosophical positions and approaches to validity, although the Leibnizian, Lockean, Kantian, Hegelian (Dialectical) and Singerian are the most significant modes from which others can be constructed. These inquiries are not about knowing something with perfect

certainty, but about what we can know, and how we can justify it, which is the issue and the utility upon which Delphi depends.

Delphi is useful when:

- The problem does not lend itself to precise analytical techniques but can benefit from subjective judgements on a collective basis
- More individuals are needed than can effectively and cost efficiently interact face to face.
- Refereeing and anonymity ensure minimal bias
- Heterogeneity of the participants is preserved to avoid the bandwagon effect.

Delphi may be characterised as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem. It is better suited to setting up a communication structure among an already ‘informed’ group that possesses the same core of knowledge. A Kantian, or ‘contributory’ Delphi, attempts to design a structure which allows many ‘informed’ individuals in different disciplines or specialties to contribute information or judgements to a problem area which is much broader in scope than the knowledge that any one of the individuals possesses. It is therefore a form of utilisation of the collective human intelligence capability that includes attitudes and feelings, and is part of the process of human motivation and action. It features:

- some feedback of individual contributions of information and knowledge
- some assessment of the group judgement or view
- some opportunity for individuals to revise views
- some degree of anonymity for the individual responses

There are four distinct phases:

1. Exploration of the subject under discussion, each member of the panel contributes additional information pertinent to the issue
2. Process of reaching an understanding as to how the group views the issue, including agreement or not and meaning of any relative terms (ie. significance)
3. Address any disagreement, underlying reasons, evaluate them
4. Final phase. All previous information analysed and feedback has taken place.

Material for consideration will be presented formally in each round of the Delphi, and responses categorised by original insight and represented to the group, giving them at least one opportunity to revise their response. The resultant pooled judgement is thus more likely to be congruent with the desired outcome, and hold greater validity than that of any one individual.

(Douglas 1970; Linstone & Turoff 1975; Helmer 1975; Mitroff & Turoff 1975; Scheele 1975; Birkett 1989; Dick 1990).

The following statements, judgements, views and opinions have been taken from the literature and are intended to get the group thinking about some of the problems encountered in attempts to value the environment. You are welcome to provide any insights you wish on the opinions given or conclusions reached. Any insights will be communicated back to the group (without comment or author), and comment sought.

NB. The words 'the environment'; 'intangibles'; 'non-market goods' and 'unpriced goods' are interchangeable

Begin Questionnaire

1. Anthopocentrism holds that only humans can have or ascribe intrinsic value, and as such all other features of the environment, whether living or non-living, can only have value through usefulness to humans. **True/False**

2. It follows that a feature of the environment or an ecosystem service must provide some utility to at least one human entity, otherwise it has no economic value. **True/False**

3. There is still a general lack of confidence in the outcomes of valuations of non-market goods and services in the environment, and uncertainties due to lack of knowledge of the resistance and resilience of ecosystems, irrespective of markets. **True/False**

4. Efforts to date to attribute values to ecosystem services seem to range from the inept to the perverse… to the resource hungry… to the good intentioned …to the poorly informed. **True/False**

5. In the absence or failure of accepted markets, no direct mechanism exists to measure or reveal prices of intangibles, so surrogate or shadow prices are used. **True/False**

6. In cost benefit analysis (CBA), conscious valuations of intangibles can be made by assessing the 'willingness to pay' (WTP) by individual preference of society as a whole. **True/False**

7. Expressed preference (WTP) surveys have been the prime methodology employed in what has become the most highly regarded and commonly used technique to value non-market goods, the contingency valuation method (CVM). **True/False**

8. The method was called the CVM because the answers to a valuation question were contingent upon the particular hypothetical market described to the respondents. **True/False**

9. The CVM is fraught with risk where respondents have no knowledge of the resource, no experience in trading it, and don't believe the market to be realistic. **True/False**

10. The CVM is also well known for producing frivolous responses. **True/False**

11. Others reject this positivist-rationalist approach, and suggest that conventional economics is totally inappropriate when dealing with environmental problems, preferring the holistic approach of ecologists. **True/False**

12. WTP is only useful in valuing a particular attribute of the environment eg. recreation, and is never areal, making it worthless to evaluate terrestrial ecosystems. **True/False**

13. Much of the early work dealing with environmental goods in CBA was based on the Cartesian paradigm, which posits that there exists a reality driven by immutable laws. **True/False**

14. Science sought to discover the true nature of this reality by breaking down components of a complex world into discrete parts, analysing them and making predictions about the world on the basis of these results. **True/False**

15. The ultimate aim was to discover, predict and control natural phenomena. Such science was equated with true knowledge. **True/False**

16. The many variables and feedback effects inherent in the natural world obfuscate proper modelling of environmental impacts on ecosystems. **True/False**

17. The problem becomes even more difficult when links between very complex phenomena and the economy are sought. **True/False**

18. The reductionist presumptions of CBA that complex ecosystems, no matter how modelled or analysed, can be reduced to a single number, is absurd. **True/False**

19. Analysts that attempted to measure the intangibles (typically environmental goods and services) have been accused of trying to 'measure the immeasurable', and castigated for trying to apply a monetary value to everything. **Text response required**

20. Some neo-classical economists and others are strongly critical of the practise of converting unpriced intangibles to a common monetary unit. **Text response required**

21. It has been called ‘self deception’, and ‘the deception of others’, that to ‘measure the immeasurable’ is absurd. **True/False**

22. Nothing else compares to the medium of money in the marketplace, which is the context in which millions of individuals express countless preferences daily. **True/False**

23. People express preferences for or against goods and services by buying them or not buying them. **True/False**

24. Money is also regarded as the store of value (in terms of income and wealth), such that to express preferences or vote, it is assumed one must possess money **True/False**

25. Cash is the obvious choice, having the advantage of comparison with its own investment cost on a case-wise basis. **True/False**

26. There is an instinctive conviction that what cannot be measured may not exist. **True/False**

27. Society can put a monetary value on a non-market good or service (unpriced), otherwise known as an intangible, under the right experimental conditions. **True/False**

28. An evaluation technique based on peoples' expressed preferences backed up by the ability to pay raises profound issues to do with anthropocentrism. **Text response required**

29. An evaluation technique based on peoples' expressed preferences raises profound issues to do with information variability across groups, effects of value aggregation across groups and the positivist-rationalist approach. **Text response required**

30. What do you perceive to be the most important issues in trying to ascribe monetary values for intangibles (unpriced goods), typically environmental goods and services? **Text response required**

31. If trading markets were established for ecosystem goods and services, how do you think this will enhance or finance conservation? **Text response required**

32. What possibility, do you think, exists for global business capturing markets for ecosystem goods and services? Is this a good thing? **Text response required**

33. If it is not a good thing, how do you think this can be avoided? **Text response required**

34. By developing a method to ascribe dollar values to ecosystem goods and services and thus finance conservation by way of establishing

trading markets in them, natural resource utilisation can be made sustainable. **True/False**

35. In the sense of my primary interests relative the natural environment, I am best described as a neoclassical economist. **True/False**

36. In the sense of my primary interests relative the natural environment, I am best described as an environmental economist. **True/False**

37. In the sense of my primary interests relative the natural environment, I am best described as an ecological economist. **True/False**

38. In the sense of my primary interests relative the natural environment, I am best described as a natural resource manager. **True/False**

39. In the sense of my primary interests relative the natural environment, I am best described as a geographer. **True/False**

40. In the sense of my primary interests relative the natural environment, I am best described as an ecologist. **True/False**

41. In the sense of my primary interests relative the natural environment, I am best described as an environmental scientist. **True/False**

Submit

Dr Ian Oliver	Senior Research Scientist, Ecosystem Processes and Biodiversity Unit. Dept of Land and Water Conservation
Dr Mary McCrudden	Conservation Economics Unit, NSW National Parks and Wildlife
Ian Tait	Ecosearch Consultants
Dr Neil Byron	Commissioner, Productivity Commission, Canberra
Mathew Campbell	Senior Advisor – Strategy & Environment, Queensland Transport
Dr Rhonda Green	Australian School of Environmental Studies, Griffith University
Dr Jean Claude Eono	Economics Unit, Policy Division, Queensland Govt.
Associate Professor Steve Turton	Deputy Chief Executive Officer, Rainforest CRC
Andrew Date	James Cook University
Professor David Kemp	Faculty of Rural Management, University of Sydney
Dr Lex Cogle	Dept of Natural Resources and Mines, Mareeba
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Warwick Moss	Economic Policy Officer, Murray Darling Basin Program, WWF for Nature, Australia
Jasmine Westerman	Environmental and Planning Manager, SMEC
Dr Brian Wilson	NSW Dept of Land & Water Conservation, Centre for Natural Resources
Iris Greene	Poet and author
Dr Greg Brunskill	Biochemist, Australian Institute of Marine Science

Nicola Dowding	PhD Scholar, James Cook University
Dr Robert Henzell	Principal Research Officer, Animal and Plant Control Commission
Stephen Lusher	Principal, Political Lobby, former Federal Member for Hume
Dr Will Edwards	Lecturer, Evolutionary Ecology, James Cook University
Karen Benn	Environment Australia, Cairns
Dr Jude Westrupp	Senior Natural Resource Officer (Native Vegetation Management) NRM (Qld)
Barry Doneley	Business Development Director, Catering Industries of Australia
Bernie Masters	Ecology Society of Australia
Celeste Forestal	NSW Environmental Protection Authority
Jack Taylor	Director, EPA, Brisbane
Professor Richard Cardew	University of New South Wales
Brian Wilson	NSW Dept of Land and Water Conservation. Centre for Natural Resources
Bruce Jennison	Principal Conservation Office, Wet Tropics Management Authority
Scott Cunliffe	Tourism Consultants, Salzburg, Austria
Dr Phillip Cosser	Environment Protection Authority, Brisbane
David Morgan	Manager Environmental Tourism, Tourism Queensland

Appendix D

Conceptual models for the level of provision of ecosystem goods and services

Level of Protection (LOP) Models

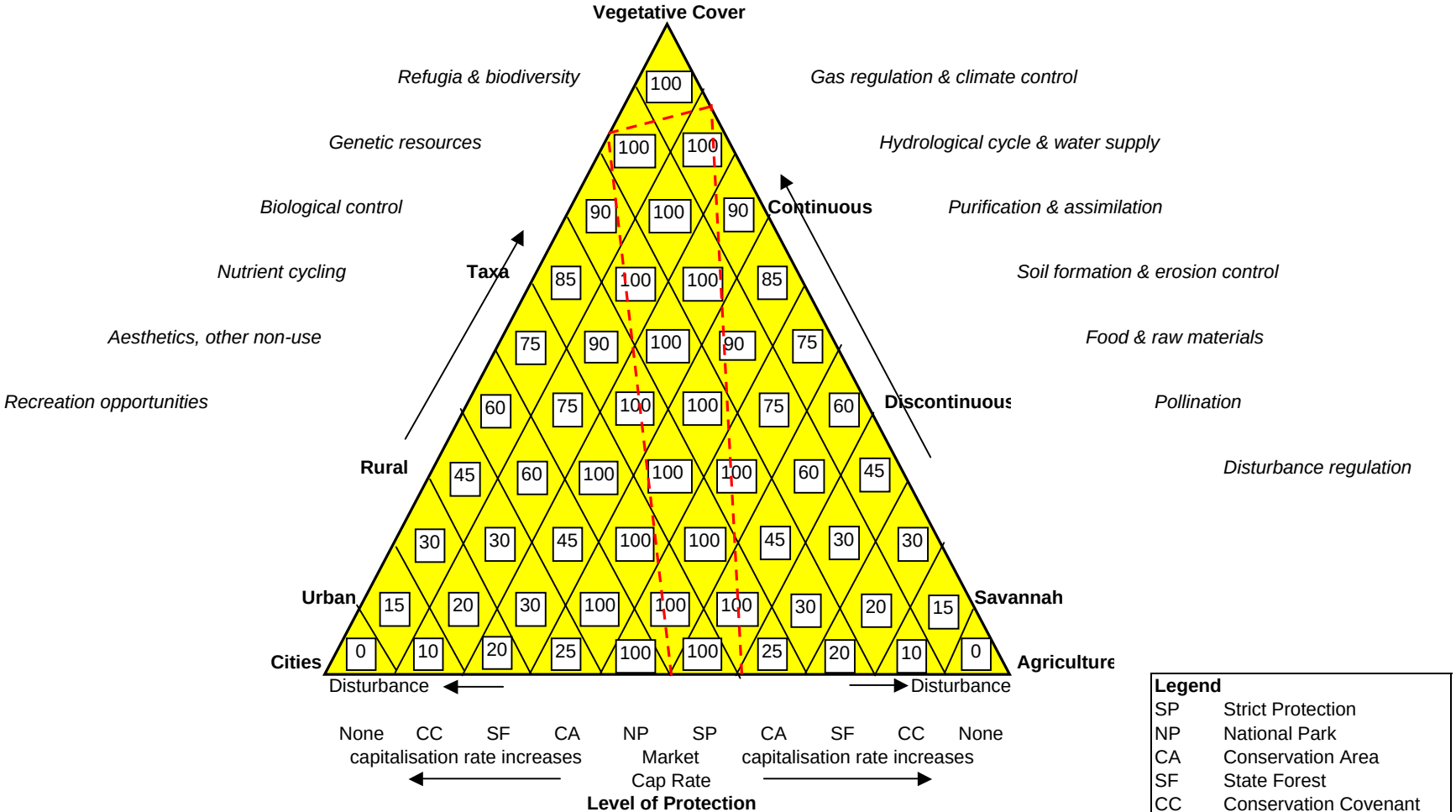


Figure D1. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, National Park: 99%

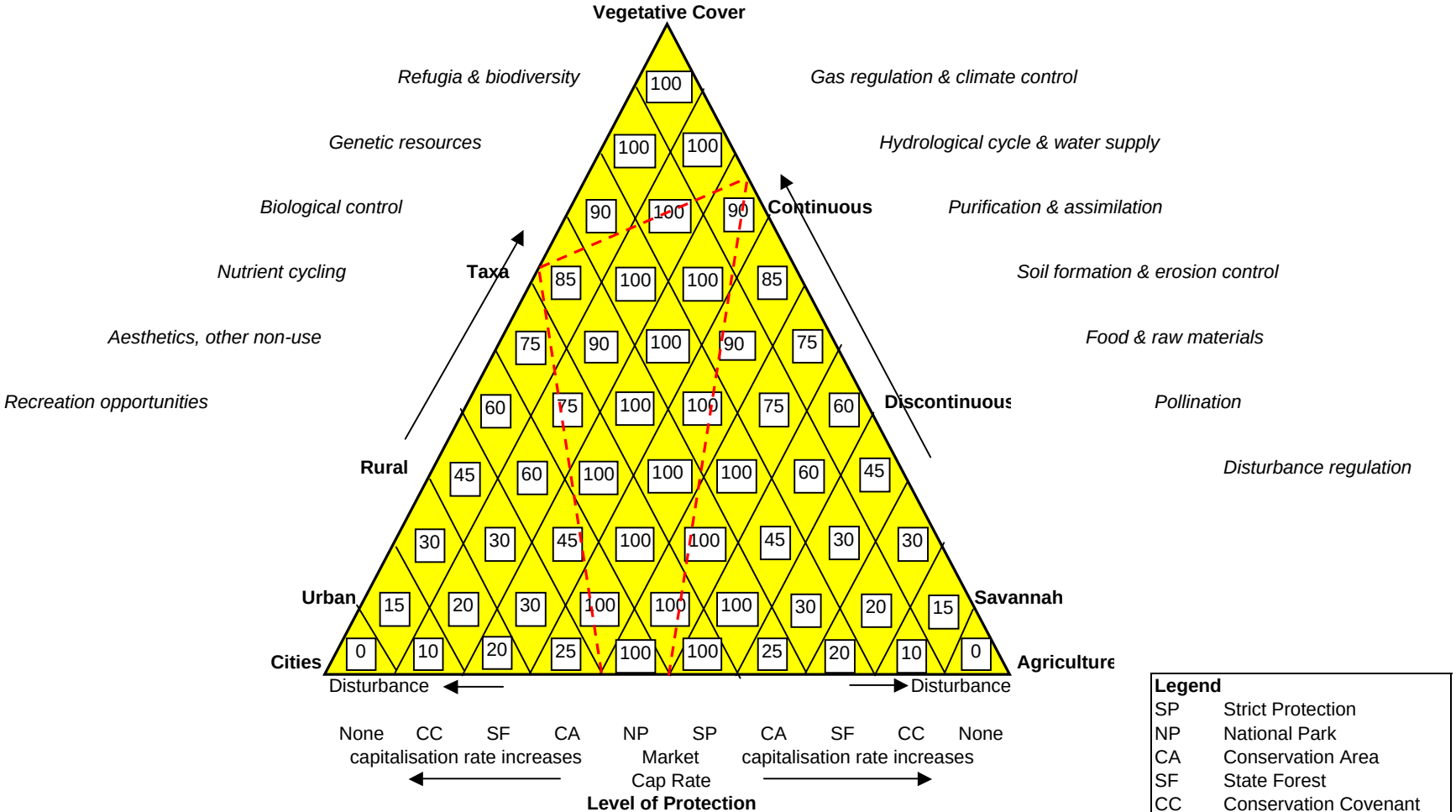


Figure D2. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, National Park: 92%

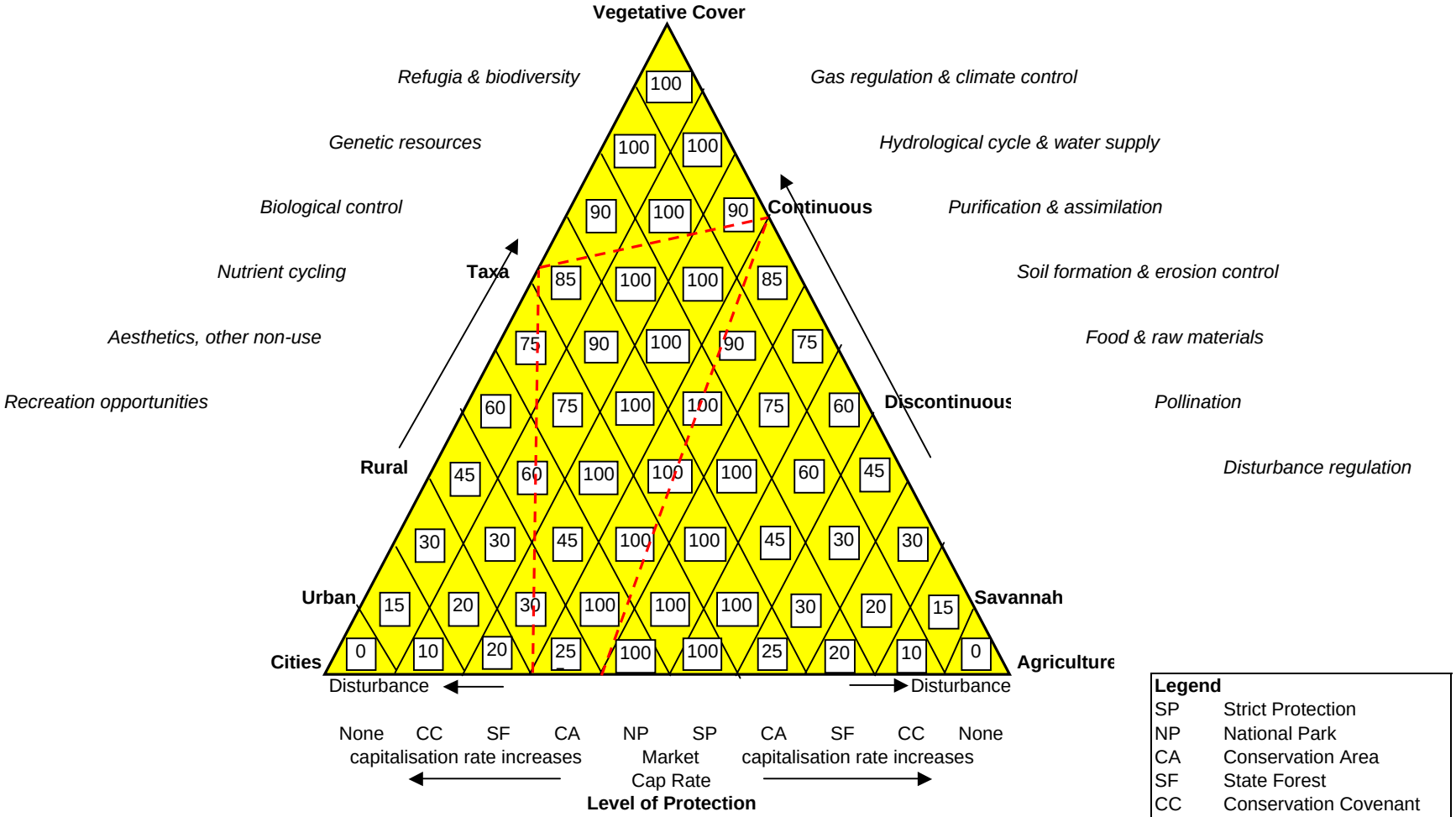


Figure D3. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Conservation Area: 84%

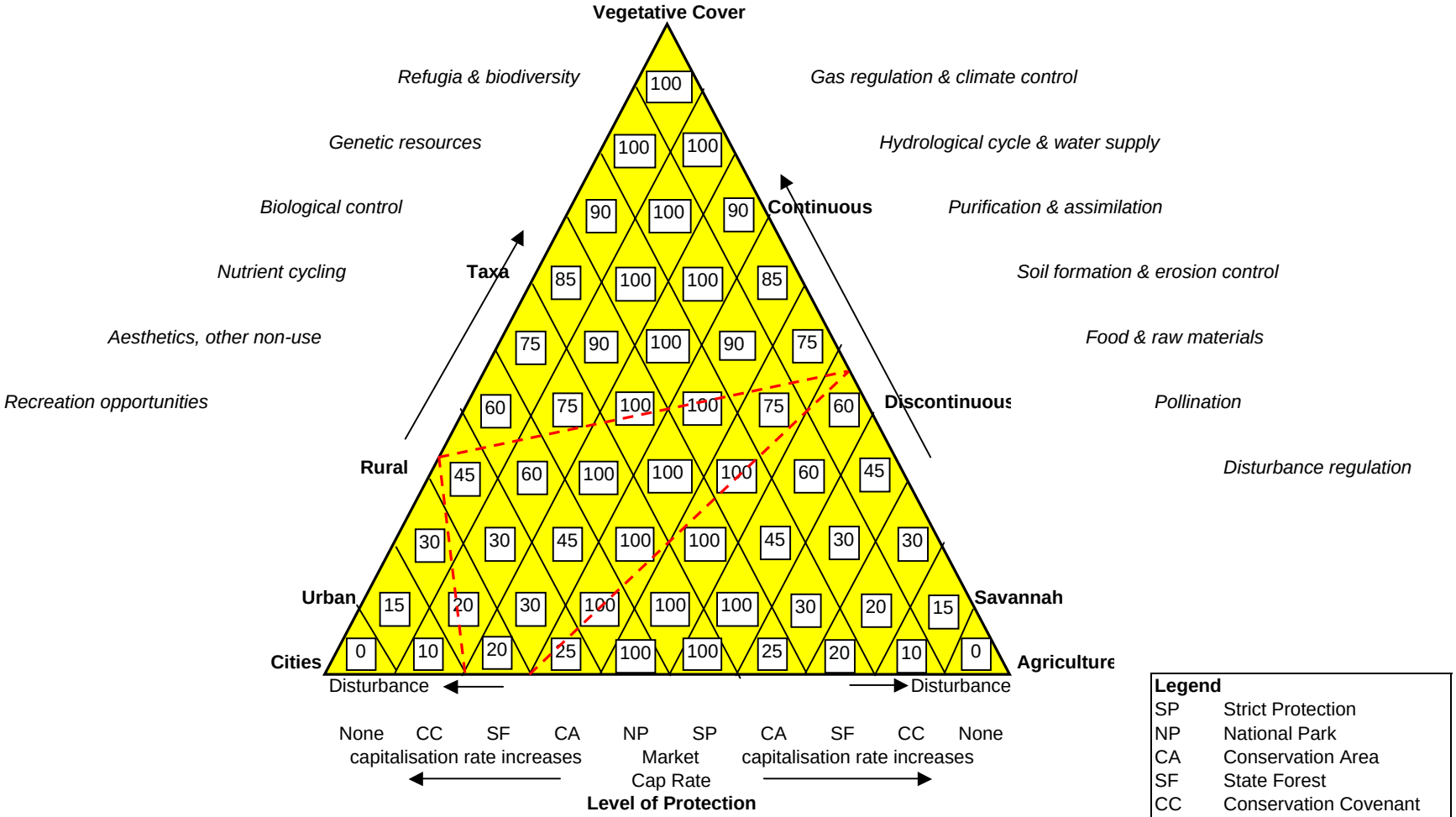


Figure D4. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, State Forest: 66%

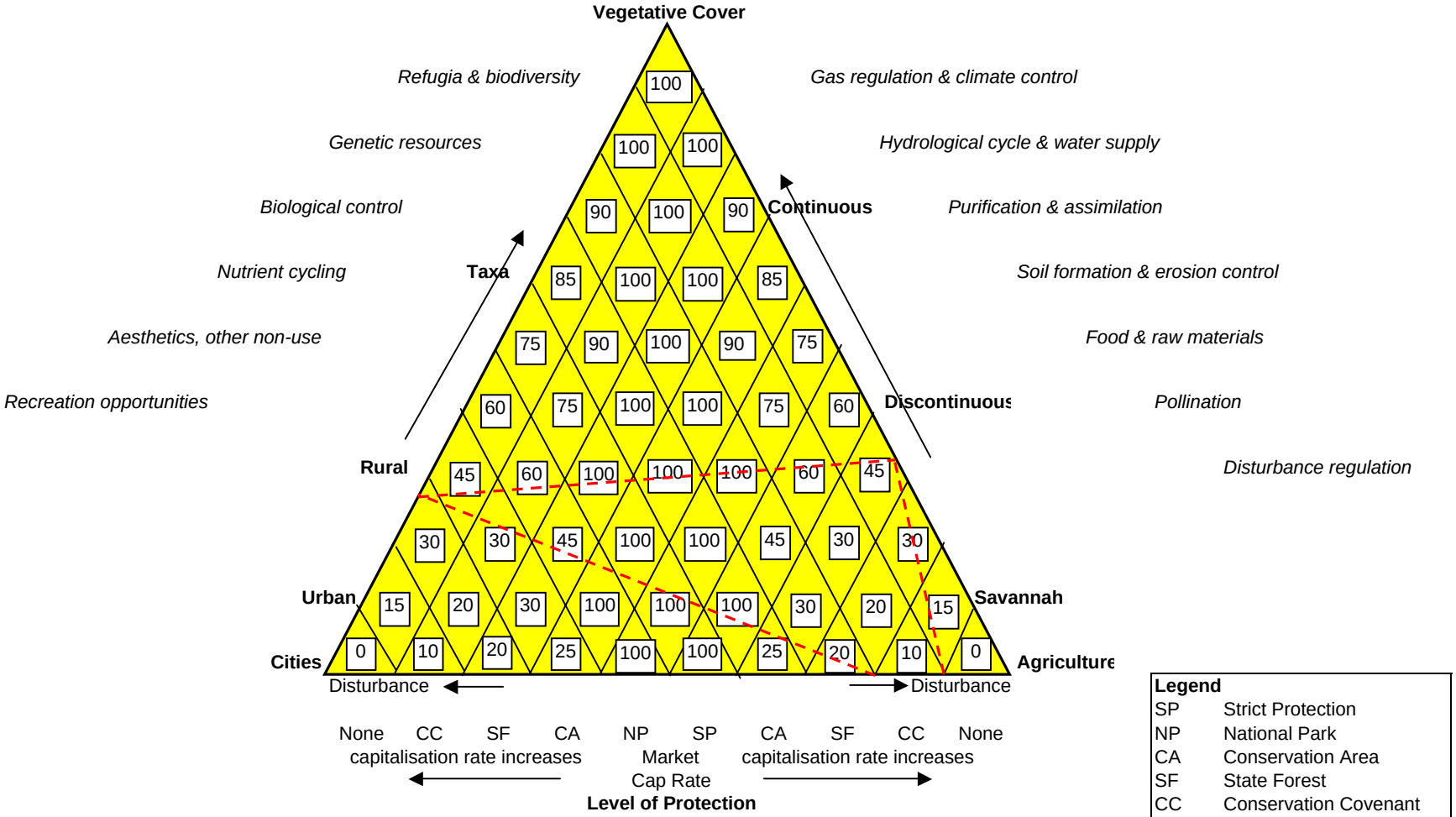


Figure D7. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Conservation Covenant: 56%

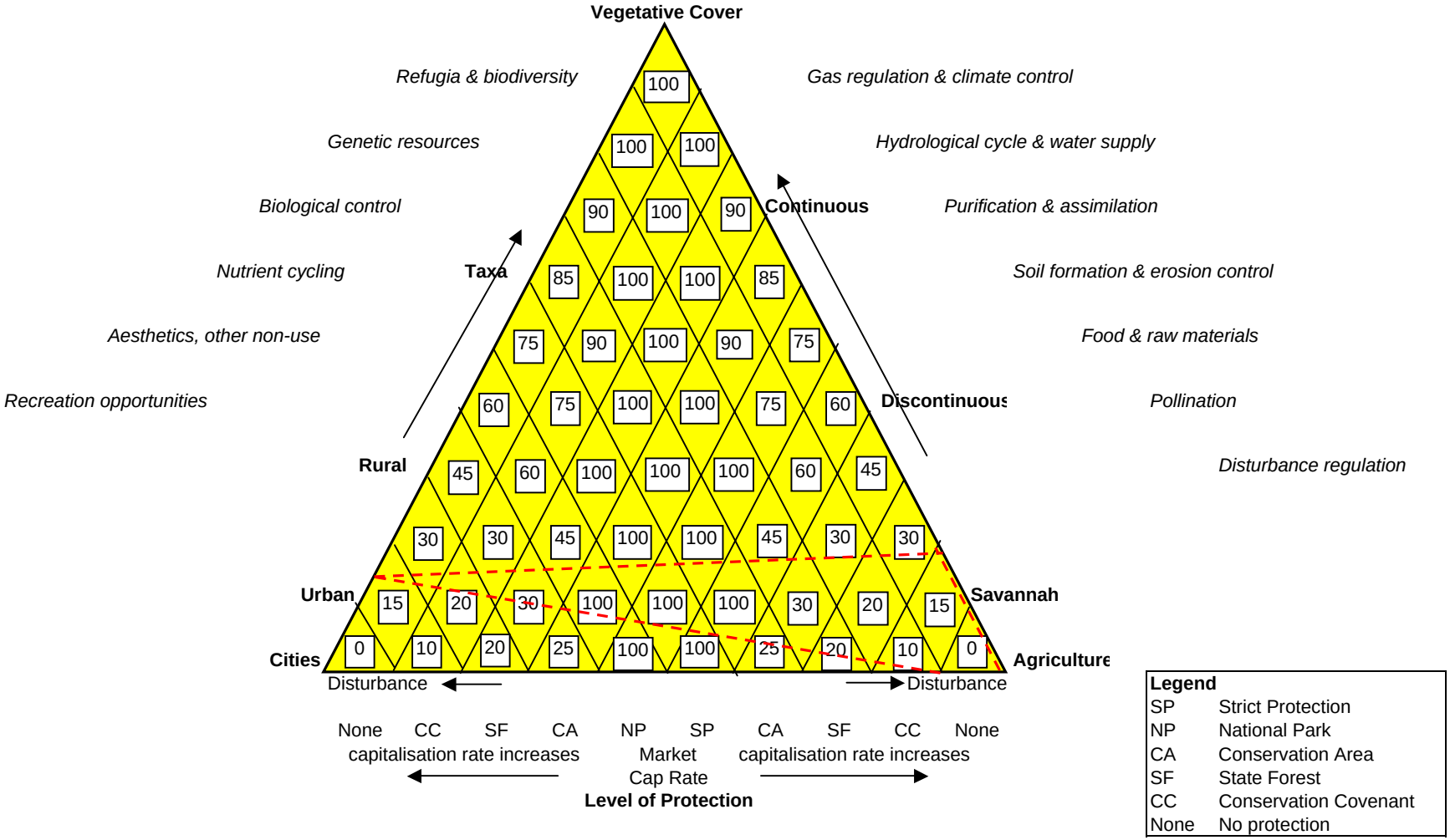


Figure D8. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, No protection, savannah/agriculture: 48%

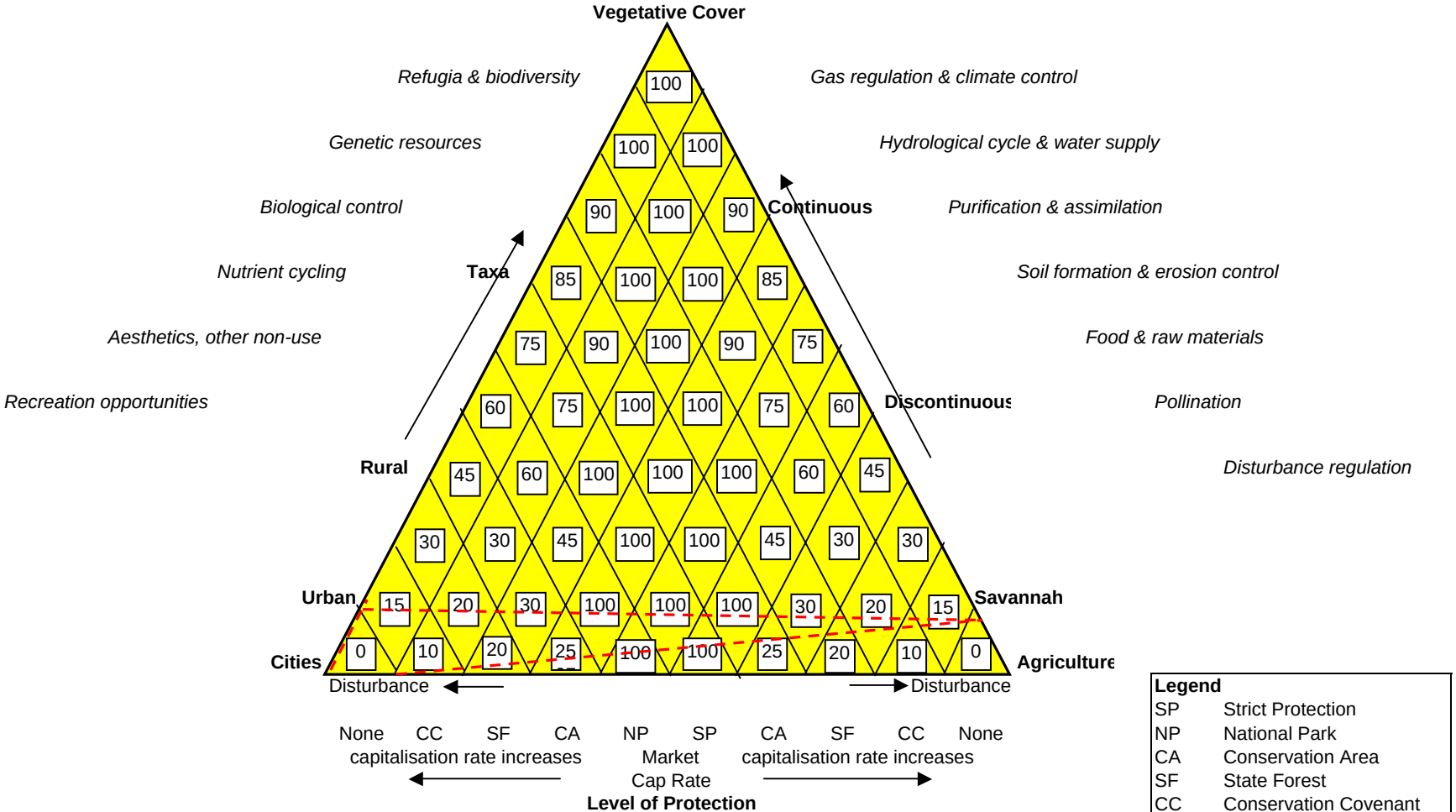


Figure D10. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection
Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.
This example, No protection, City/Urban: 39%

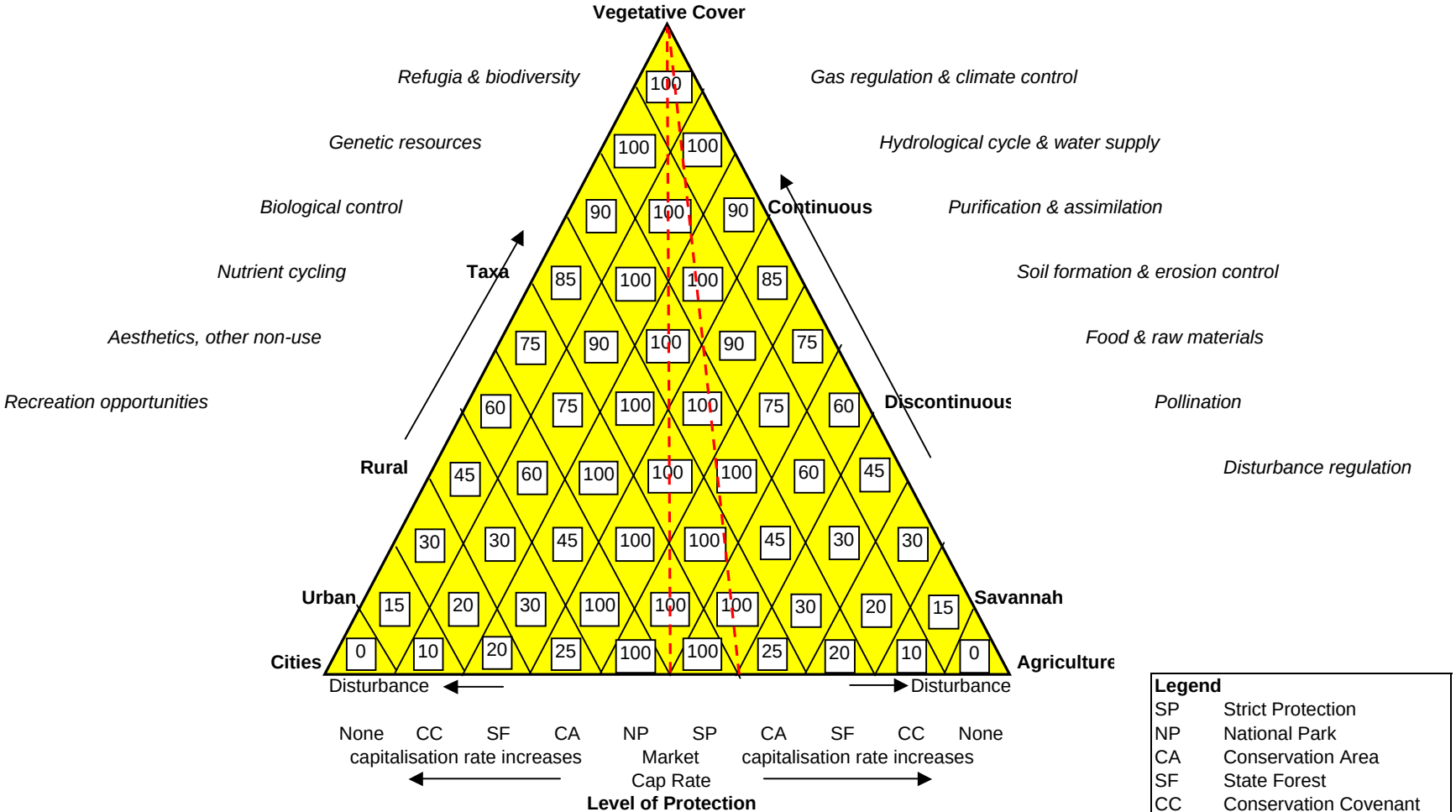


Figure D12. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection
Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.
This example, Strict Protection: 100%

Land Use Characteristic (LUC) Models

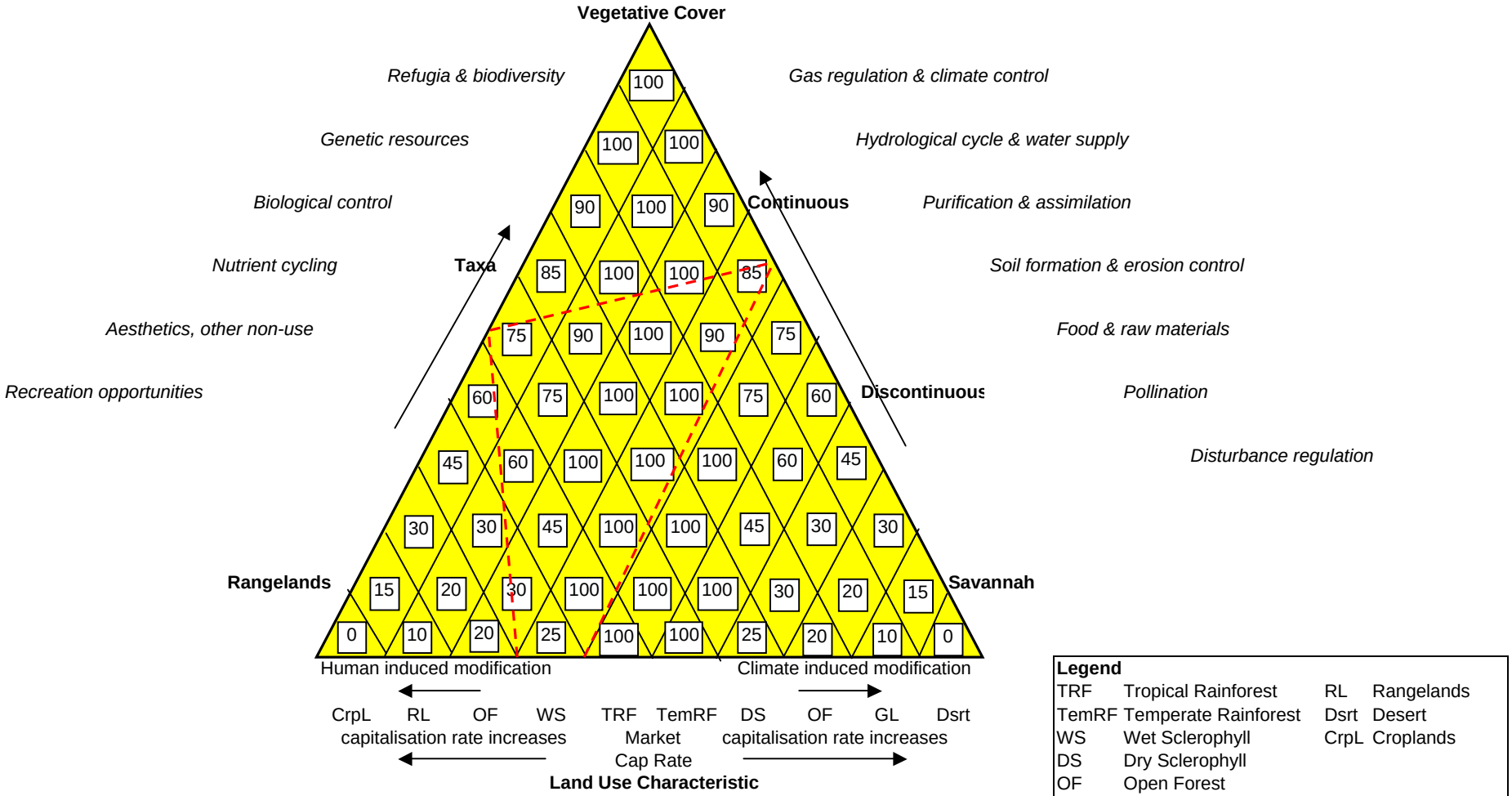


Figure D5. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Wet Sclerophyll Forest: 79%

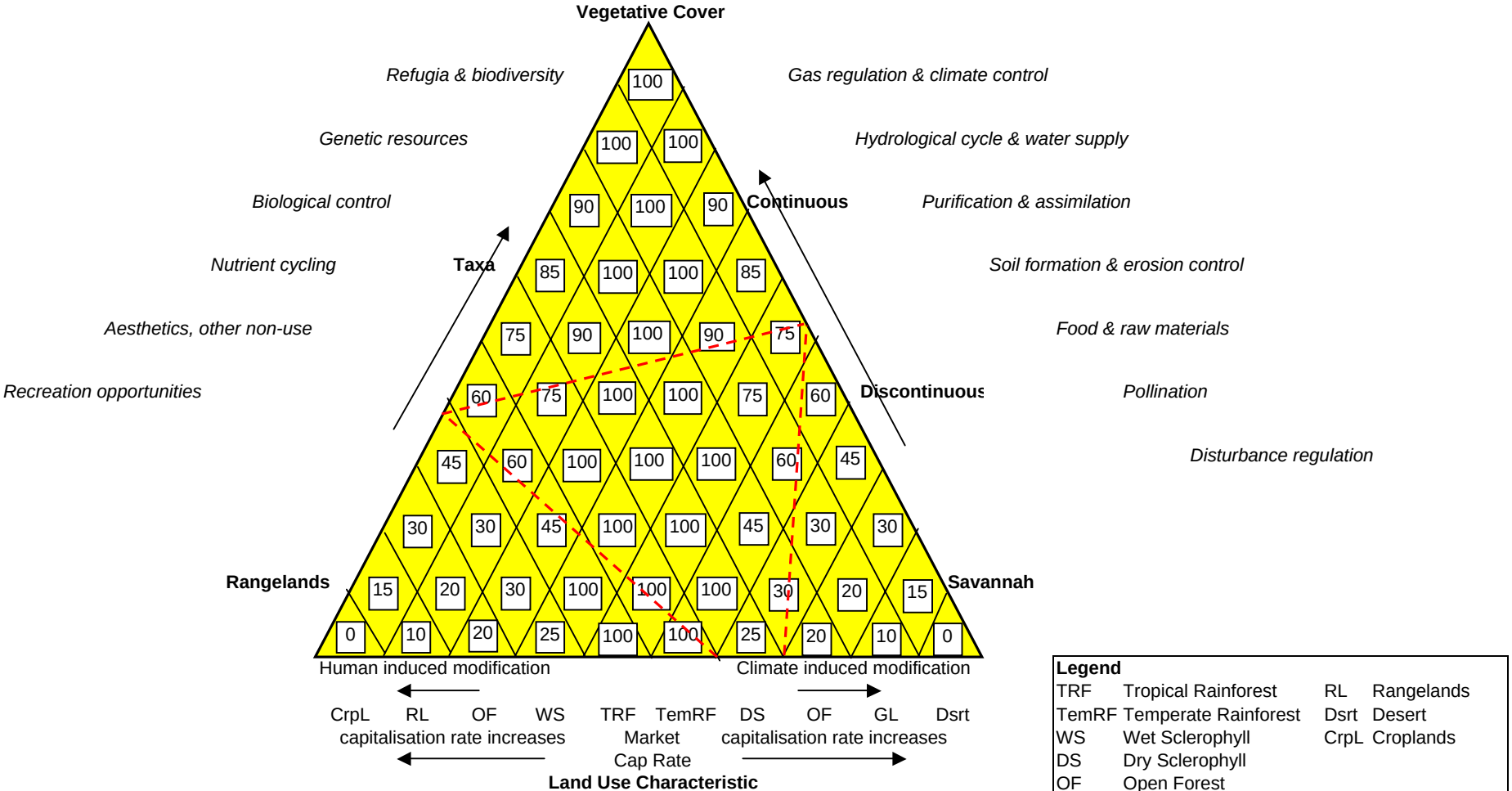


Figure D6. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Dry Sclerophyll Forest: 76%

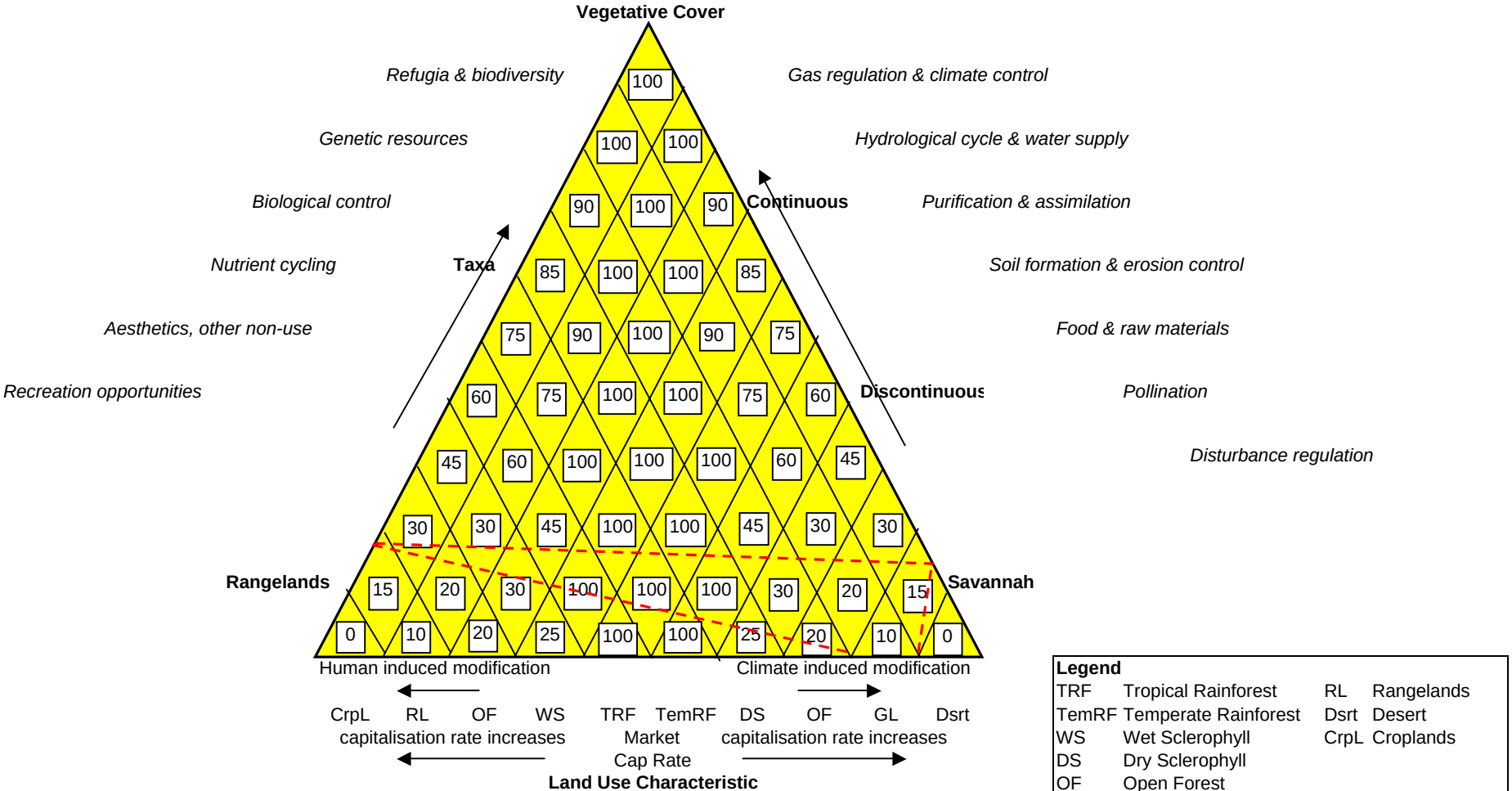
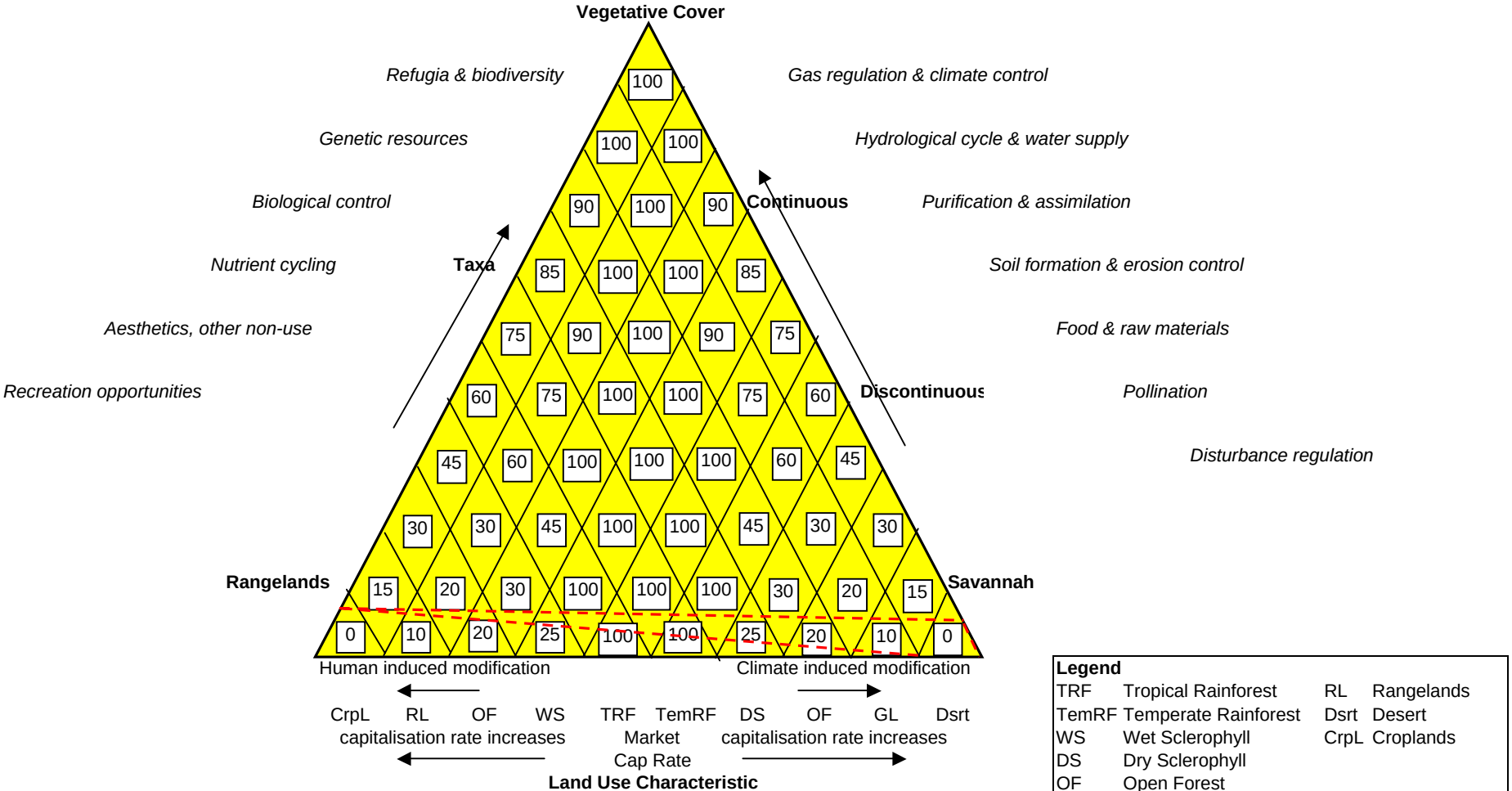


Figure D9. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

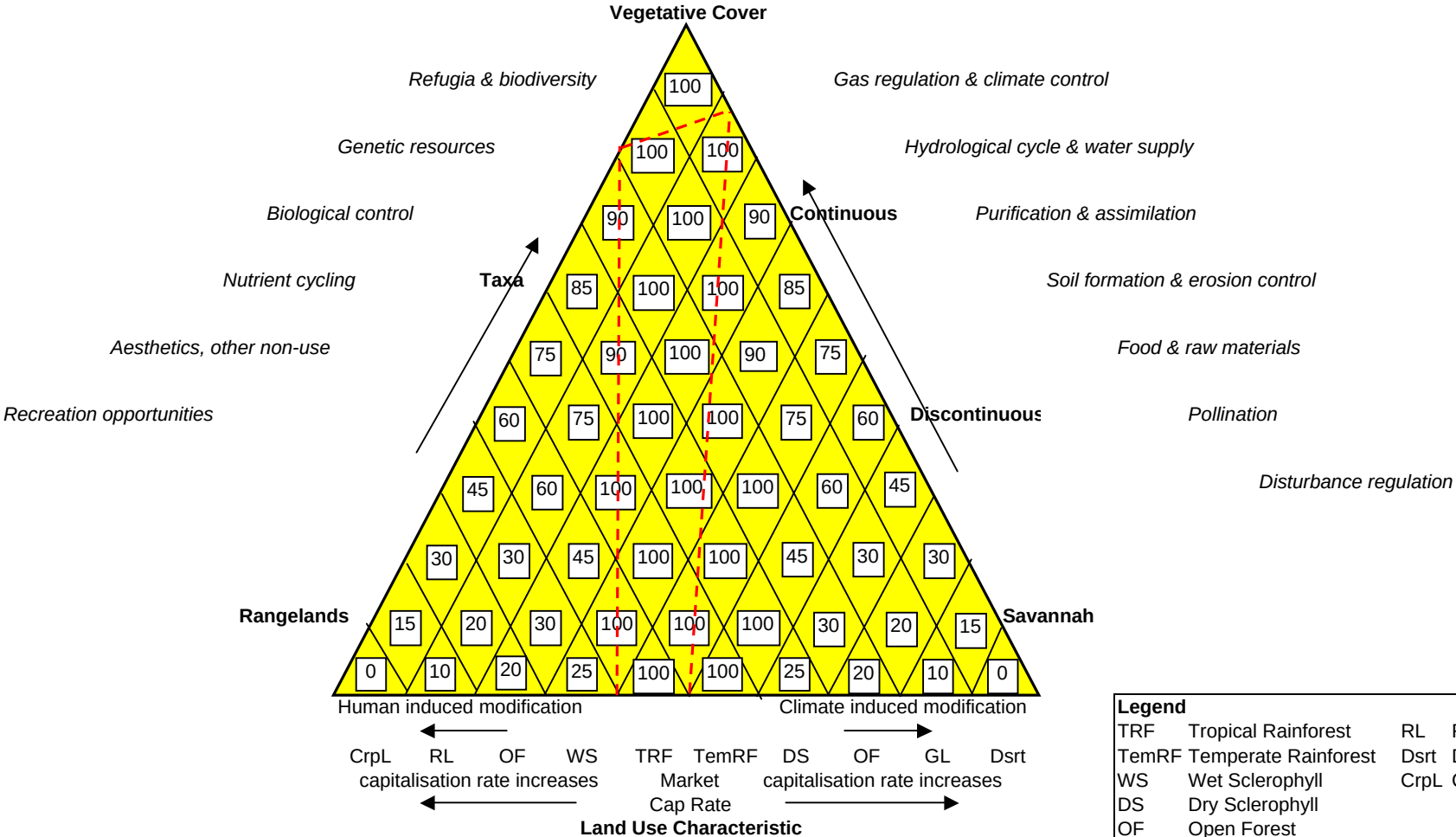
Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Grasslands/Mediterranean: 50%



Legend			
TRF	Tropical Rainforest	RL	Rangelands
TemRF	Temperate Rainforest	Dsrt	Desert
WS	Wet Sclerophyll	CrpL	Croplands
DS	Dry Sclerophyll		
OF	Open Forest		
GL	Grasslands		

Figure D11. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic
Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.
This example, Desert: 39%



Legend			
TRF	Tropical Rainforest	RL	Rangelands
TemRF	Temperate Rainforest	Dsrt	Desert
WS	Wet Sclerophyll	CrpL	Croplands
DS	Dry Sclerophyll		
OF	Open Forest		
GL	Grasslands		

Figure D13. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Tropical Rainforest: 99%

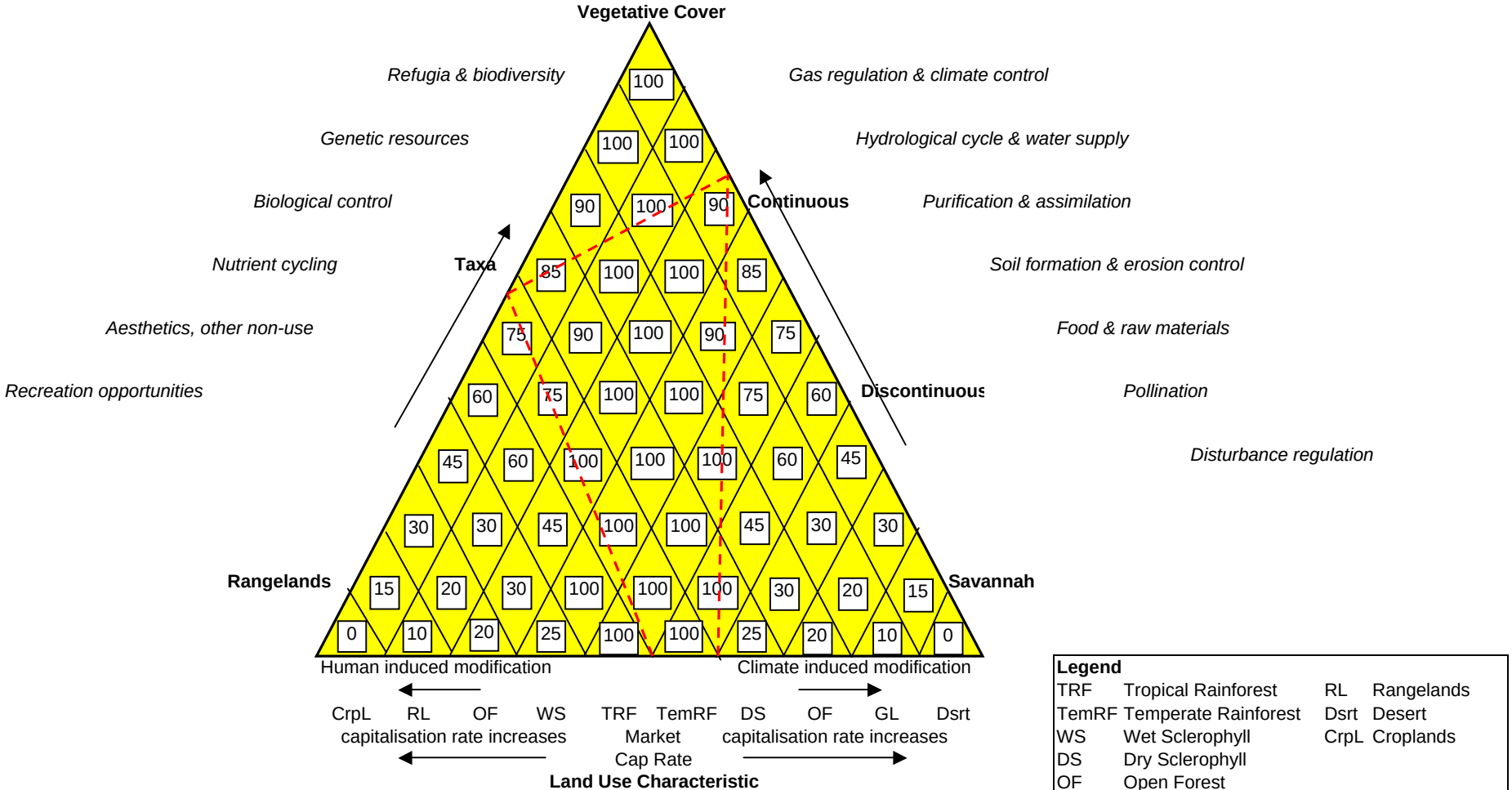


Figure D14. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Temperate Rainforest: 94%

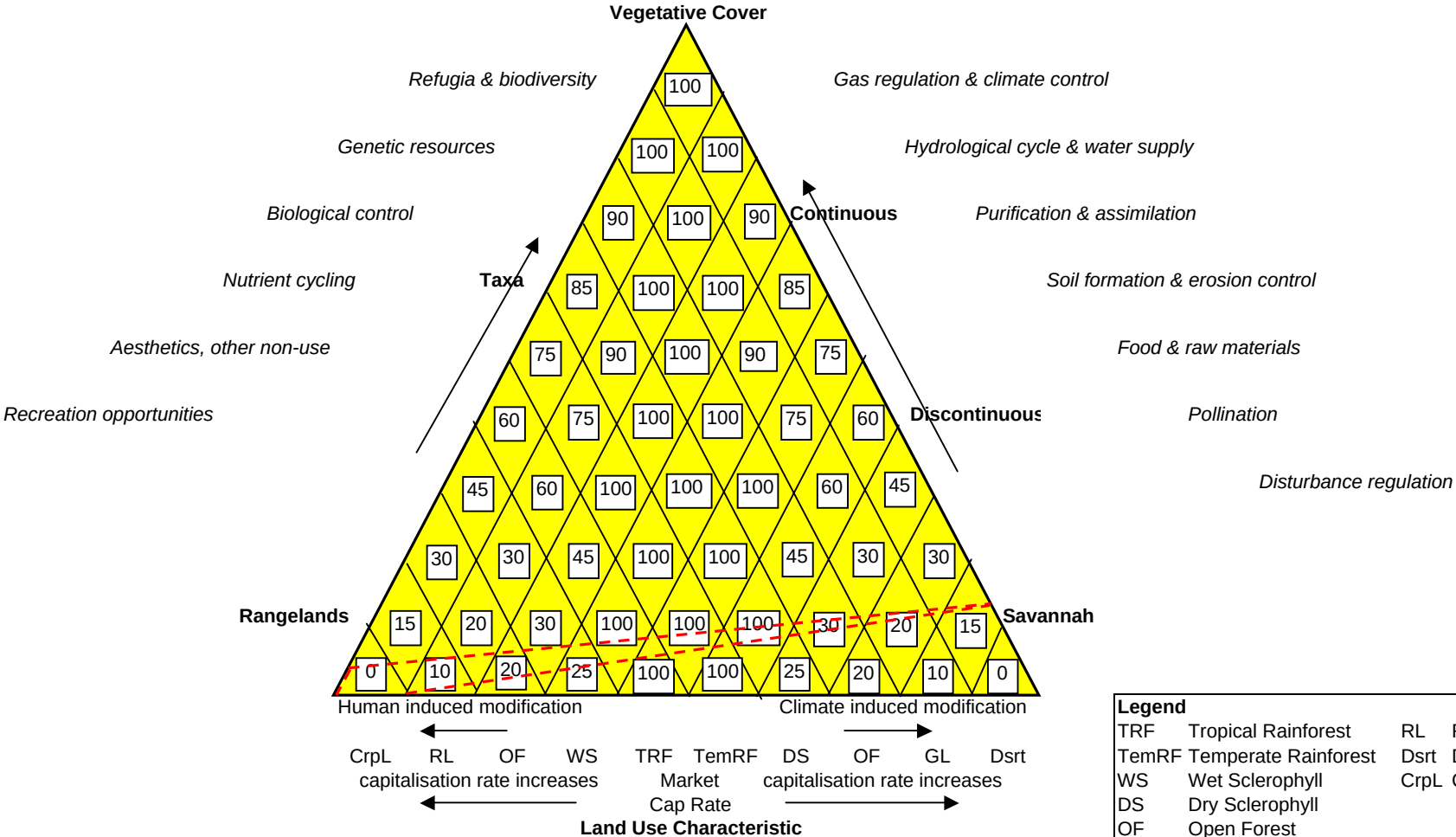
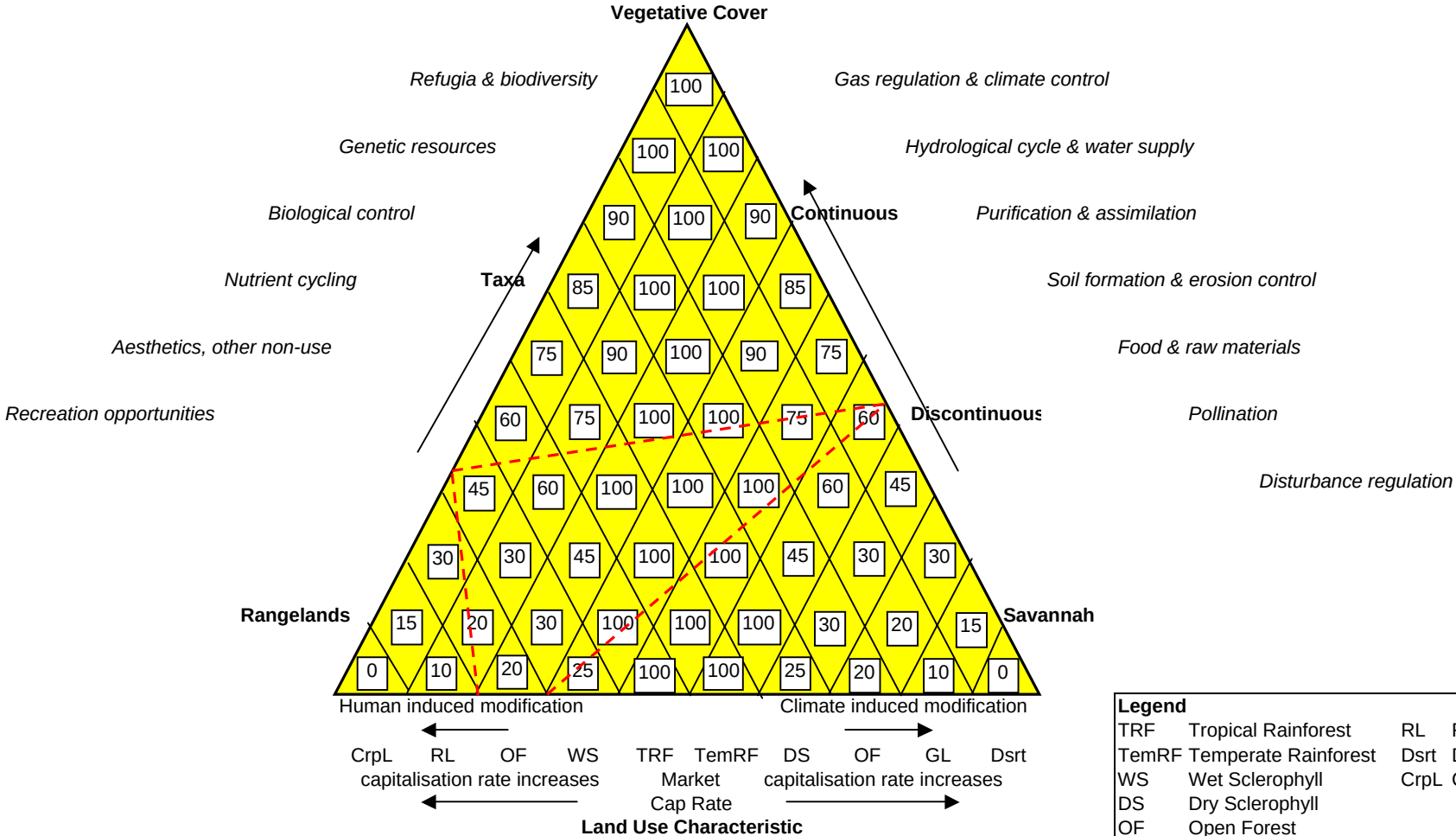


Figure D15. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Croplands: 43%



Legend			
TRF	Tropical Rainforest	RL	Rangelands
TemRF	Temperate Rainforest	Dsrt	Desert
WS	Wet Sclerophyll	CrpL	Croplands
DS	Dry Sclerophyll		
OF	Open Forest		
GL	Grasslands		

Figure D16. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Open Forest: 67%

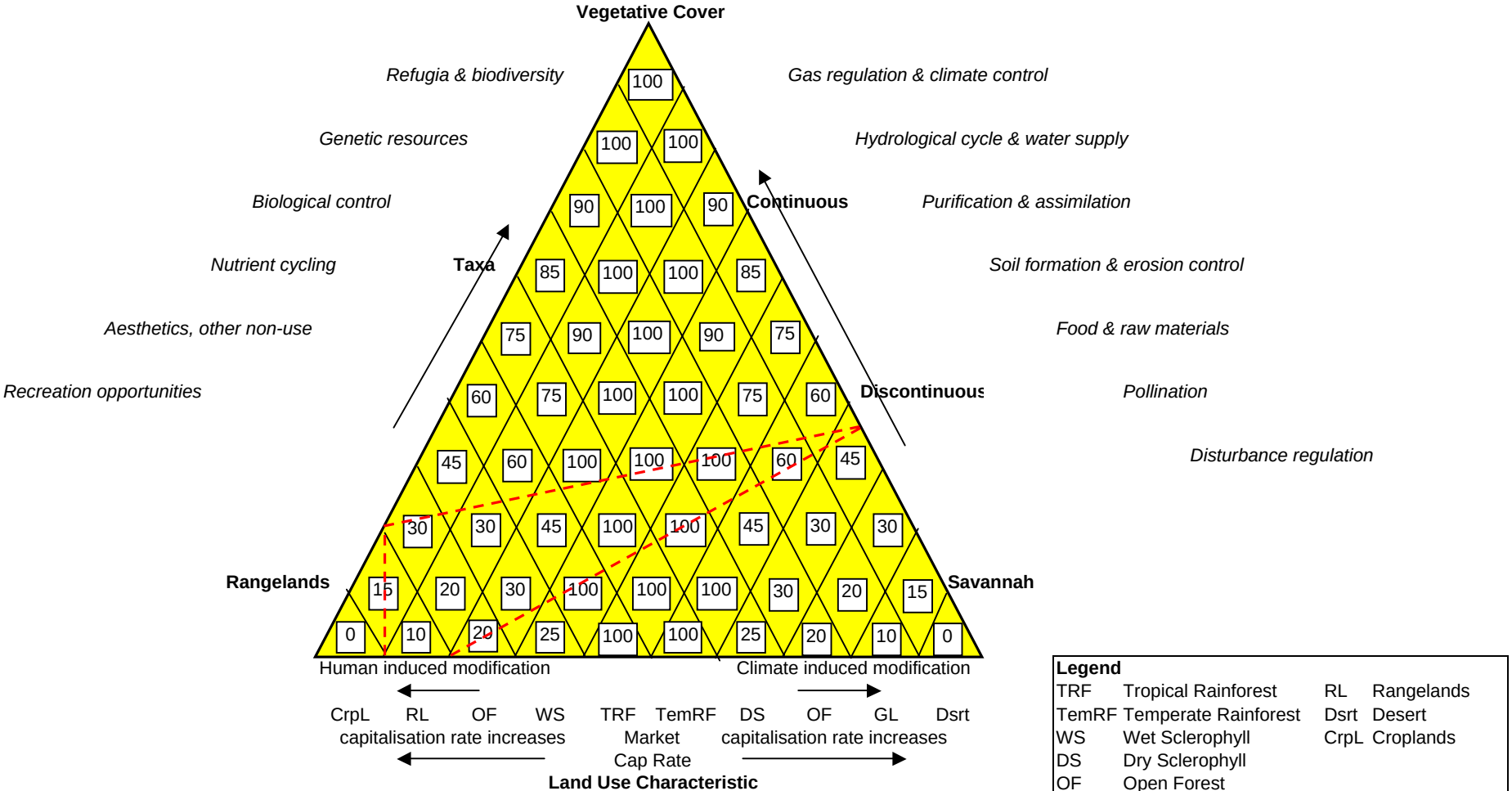


Figure D17. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, Rangelands: 57%

Appendix E

Preamble for round 2 and results of round 1 of the Delphi Inquiry

Greetings, and welcome to the second round of the Delphi.

You will have received the results and feedback from round one. In order to analyse the results, I grouped the panellists into their nominated disciplinary category, ie. ecological economist, environmental scientist etc., calculated frequencies of 'true' responses, and tested the results using Kendalls W. The coefficient W permits the evaluation of the extent of concordance or agreement among ranks. It has the value 1.0 if the groups agree perfectly and 0.0 if they disagree maximally. The coefficient W for the round 1 questionnaire was 0.814, which was highly significant *(P<.0001).*

The results and feedback were rather long, however I thought it important that you at least had the opportunity to see what others in the group had said. In this and future rounds there are a lot fewer questions (<10), and the models that I have devised for the multiple criteria/attribute analysis of ecosystem goods and services are introduced. You will note that there is a part two of the survey *(download spreadsheet).*

The spreadsheet is a Microsoft excel file, and you will see it is arranged as a matrix of 120 cells, ie. 20 ecosystem attributes and 6 criteria. The criteria are given maximum weightings, and it is your task to decide which attributes are the most important given the criteria. There are more directions on the spreadsheet. If you are unfamiliar with excel, you need only left click with the mouse on the cell you wish to complete, and type in the weighting (eg. 5, 3 etc.). The multiple criteria/attribute analysis is necessary to ascribe values to individual ecosystem goods and services, otherwise known as 'shadow prices', which will become evident in the appropriate surrogate market. The shadow prices are intended to be no more nor less than the starting price for ecosystem goods and services, until market forces take over.

Methodology.

In round 1, several questions/statements referred to the expressed preferences of individuals and society to ascribe values to the environment, known as 'willingness to pay' (WTP), and the 'contingency valuation method' (CVM). Not mentioned were revealed preference methods, the two most well known being the 'travel cost method' (TCM) and 'hedonic pricing' (HP). TCM uses the travel cost of an individual to access a natural area (say a forest) as a proxy for willingness to pay. HP uses real property values of comparable properties to establish environmental valuations, where one may be affected by, say, aircraft noise, and the other not. Both methods only ascribe 'use values' and ignore 'non-use values'.

The Surrogate Market

The surrogate market I have chosen is the property market. Revealed preferences in a surrogate market will provide a proxy for total economic value

of a resource, including use, both direct and indirect, and non-use, viz: option use, bequest and existence value.

The economic theory of value is the study of market phenomena, which attempts to analyse and explain price triggers *a posteriori* under a variety of hypothetical market situations. Conversely the theory of valuation is concerned with *a priori* interplays in actual market situations. Moreover, unlike neo-classical economic theory, valuation theory and practice is notable and validated by the pivotal role it plays in national administration, eg. taxation, and widespread acceptance by the commercial world, individuals and the judiciary.

Parallels from Biblical times and Ancient Greece and Rome

Many parallels can be found that support modern valuation practice. The Mosaic Land Laws were based upon the assumption that the estate in fee simple rested with God, with no permanent ownership ascribed to an individual. Perhaps another way of saying that the value of essential life-supporting natural resources such as clean air or water are without monetary consideration (infinity), or are indeed, in the realm of divinity. Land in the Roman Empire was divided into theoretically equal units called capita, which normally signified the labour expended on it (Capitatio under Diocletian). Iugum was the term used for real property, with iuga a yoke of oxen, and the underlying valuation theory was that land of varying fertility and terrain would require a different amount of labour expended on it. The Domesday Inquest was the first real large scale valuation to levy taxes as a right devolved to William the heir of the confessor to wage an occasional war. The Danegeld was levied three times during the reign of the conqueror. The questions were very well designed and would not be out of place in a modern valuation report. The last three demanding if the property was worked to it's full capacity. This is equivalent to the modern valuation principal of highest and best use.

Usufruct: *n & v* (in Roman and Scots law) The right of enjoying the use and advantages of another's property short of the destruction or waste of it's substance. *l*. *usus*~use; *fructus*~fruit. Thus it could be said that we hold our conservation areas in usufruct. *Usus Fructus* per annum is synonymous with 'capitalisation rate' in valuation practice. These sentiments are reflected in the context that Rainforest Aboriginal people in the Wet Tropics World Heritage Area believe that natural and cultural values are inextricably entwined and thus the forests represent a living cultural landscape. Accordingly in the context of ecosystem services, any development is synonymous with degradation. The more intense the development, the less ecosystem services are intact.

Unimproved value: A basis for taxation

People have revealed their preferences since time immemorial to purchase property for a multitude of uses. The basis of rating in all local government areas world-wide is either the unimproved value or the assessed annual value. The unimproved value is derived by applying valuation methods according to the principle of "highest and best use". Unimproved value,

therefore, is the value of a natural resource or an opportunity. Although the courts insist that the improvements on the subject land are to be ignored, they also insist that communal effort is to be reckoned with. Improvements made by Governments are of vital importance. The value of a particular piece of land is the value of civilised government at that spot. It is the value which the presence of the community gives to the land and which the community unconsciously assesses. It is something which is already in existence and must be discovered, not invented. It will be seen, therefore, that unimproved value is in reality the capital value of the economic rent of a piece of vacant land or other natural resource.

Three primary methods of valuing property:

- Summation
- Capitalisation (Block Buildings Ringwood P/L v The City of Ringwood. Vic L & V Crt 5/12/67).
- Comparable Sales {Full High Court on Appeal, MacDonald v The Deputy Commissioner of Taxation (20 CLR 231)}

Incorporating amongst others, these concepts:

- Market value {Spencer vs The Commonwealth (1907) 5 CLR 418}.
- Unimproved value {Toohey's Ltd v The Valuer General (1925) AC 439}.
- Highest and best use {The Minister v Stocks and Parks Investments P/L (1973) 129 CLR 385}.

The precedent followed by all Courts in Australia when dealing with the valuation of land, under the Land Acquisitions Act and pre-dating the Federal Land Tax Act by many years is, Spencer v The Commonwealth. Instances of absolutely unimproved land are becoming more rare as time goes on and valuers are most frequently obliged to deduce unimproved value from sales of improved property, as stated by Lord Dunedin in Tooheys Ltd v The Valuer General, "What the act requires is really quite simple. Here is a plot of land – assume there is nothing on it in the way of improvements, what would it fetch in the market?"

Australian Accounting Standards (AAS) 227 also now requires that all public land within a local government area be assessed, ie land under utilities, roads, powerlines etc. This is achieved by using sales of adjoining land as comparables.

The Wet Tropics Bioregion

The Wet Tropics Bioregion includes all or a part of ten local government areas. The median unimproved capital value of rateable land in the region is $3,654 per hectare.

As some ecosystems services are essential to life, it follows that unrateable land, ie land held in the public domain (conservation areas) must be worth at

least as much for the ecosystem services that it provides ie. the benefits stream, as rateable land put to its highest and best use. A capital value can then be used to determine an annual flow (stream of benefits), the *Usus Fructus* per annum, just as an annual stream of benefits can be capitalised to produce a capital value. Harold Hotelling (1895-1973) posited that conservation only occurs when a resource is generating a flow of goods and services at a rate greater than the rate of interest. Therefore application of an appropriate capitalisation rate will give us the net annual value (ie. after costs of conservation) of the stream of benefits that emanates from land in its natural state (the *Usus Fructus* per annum).

The Value of the National Parks in the Wet Tropics World Heritage Area

Applying a capitalisation rate of 6.5% to the median value of land in the Wet Tropics Bioregion will place a total value on ecosystem services in the National Parks within the Wet Tropics World Heritage Area (32% of the area), assuming the services are 100% intact, of $67.94 million per annum.

Now we need to break that down to values for individual ecosystem services, and that is where the multi-model multiple criteria analysis comes in. I have applied weights and sensitivities when testing the models, and results of these indicate values as follows (for eg.).

- Biodiversity: $6.326 million dollars per annum
- Catchments: $1.805 million dollars per annum
- Aesthetic, cultural and spiritual qualities: $1.765 million dollars per annum
- Climate and gas regulation (together): $12.272 million dollars per annum

Arriving at a valuation when ecosystem services are not 100% intact, ie as in degraded land or land partly developed, which will be most often the case, will be dealt with in round 5.

Now I need the panel to try to reach consensus as to what the 'right' adjusted weight of each attribute really is (ie. after applying the 'right' sensitivity). The sensitivity model is model three, in round 4. Please complete the questionnaire and download model 1 on the prompt.

A Name for the Trading Unit

The environment is a merit good, not merely to be determined by the aggregation of individual…willingness to pay at any point in time. In accord with this philosophy, and to remove any odium that may attach to the concept of applying dollar values to the environment, I have coined a term for the trading unit designated for ecosystem services in this study: **the ECOMERIT**.

Questionnaire

The Methodology

Please complete ALL questions and then select the *Submit* button at the bottom of the page.

42. Human activities have grown so large and pervasive that they are beginning to affect the ecological life support system itself. **True/False**

43. Costs and benefits not included (when they should be) in market prices (ie. externalities) affects how people interrelate with their environment. **True/False**

44. Biodiversity etc. is not adequately protected because it is not included in market signals that guide economic decisions of producers and consumers, and in turn the whole economic system. Ie. market failure (Pigou 1877-1959). **True/False**

45. Ecosystems are being lost because they don't have prices acting as a negative feedback to keep use in equilibrium with availability. **True/False**

46. Biologists say that if the true value of a species or biodiversity were understood, it would be conserved. If they were included in the market system, the markets themselves would assist in conservation. **True/False**

47. Economists argue that ecosystems are being lost because they don't have prices acting as a negative feedback to keep use in equilibrium with availability. **True/False**

48. Efforts to protect the environment can be accomplished in ways that internalise the full costs and bring out the real benefits, thus creating the necessary support for their implementation. **True/False**

49. Biodiversity supports the natural ecosystems on which life depends, enriching the soil, purifying the water, and creating the very air we breathe. The greater the biodiversity of species in an ecosystem, the more productive and stable it is. **True/False**

50. The single best opportunity to make sustainable development happen is to make investments in sustainable practices and technologies attractive to private business and private investment. **True/False**

Appendix F

Preamble for round 3 and results of round 2 of the Delphi Inquiry

Greetings and welcome to round 3 of the Delphi.

The group again reached consensus in round 2. Kendall's W of the frequencies of true responses across the disciplines was 0.747 (P<.000). The economists and geographers had similar responses to the questions, as did the environmental scientists, ecologists and natural resource managers. 94% of the panellists agreed that human activities are beginning to affect ecological life support systems, and 91% answered true to the next five statements to do with the merit of inclusion of ecosystem goods and services in the market system. However, there was less agreement in regard to the last two propositions, with a surprising 35% answering false to Q49:

"Biodiversity supports the natural ecosystems on which life depends, enriching the soil, purifying the water, and creating the very air we breathe. The greater the biodiversity of species in an ecosystem, the more productive and stable it is".

The last statement was possibly the most controversial with 32% answering false to Q50:

"The single best opportunity to make sustainable development happen is to make investments in sustainable practices and technologies attractive to private business and private investment".

It might not be a surprise to anyone to hear that this statement was made by Al Gore at the Third Annual World Bank Conference on Environmentally Sustainable Development in 1995.

The first of the models in the multiple criteria analysis produced an apparently varied response as to individual weightings of ecosystem attributes, yet statistical analysis of the panellist's set of responses proved to show significant concordance (Table 1).

Table 1. Results of Kendall's W for Model 1 (anthropocentric perspective).

Discipline	Kendall's coefficient	N	Significance
All disciplines	0.339	24	.000
Neoclassical Economists	0.589	4	.001
Environmental Economists	0.466	4	.012
Ecological Economists	0.246	8	.007
All Economists	0.331	16	.000
Geographers and Natural Resource Managers	0.315	8	.002
Ecologists	0.289	11	.000
Environmental Scientists	0.392	10	.000
All Natural Scientists	0.298	29	.000

The mean of all panellist's weightings for each attribute is thus regarded as the appropriate measure of central tendency to carry forward to later steps in the analysis (Table 2).

Table 2. Means and normalised means taken the from panellist's weightings supplied for Model 1.

Attribute	Mean	Normalised Mean
Gas regulation (atmospheric composition)	10.54	6.22
Climate regulation (temperature, rainfall)	9.83	5.80
Disturbance regulation (ecosystem resilience)	8.71	5.14
Water regulation (hydrological cycle)	9.75	5.75
Erosion control and soil/sediment retention	8.50	5.02
Biological control (populations, pest/disease control)	8.29	4.89
Refugia (habitats for resident and transient populations)	8.33	4.92
Soil formation	8.25	4.87
Nutrient cycling and storage	9.58	5.66
Assimilation of waste and attenuation, detoxification	8.79	5.19
Purification (clean water, air)	9.21	5.44
Pollination (movement of floral gametes)	8.50	5.02
Biodiversity	9.25	5.46
Water supply (catchment)	9.63	5.68
Food production (that sustainable portion of GPP)	8.96	5.29
Raw materials (that sustainable portion of GPP, timber, fibre etc.)	7.96	4.70
Genetic resources (medicines, scientific and technological resources	8.04	4.75
Recreation opportunities (nature-based tourism)	5.92	3.49
Aesthetic, cultural and spiritual, (existence values)	6.27	3.71
Other non-use values (bequest, option and quasi option values)	5.08	3.00
Total	169.42	100.00

In this round (round 3) the questions/statements are intended to focus on points of disagreement or deviation from the group view that have arisen during rounds 1 and 2, and to constitute the iterative component of the Delphi inquiry.

The second model will also be introduced. Called the 'Utilitarian Perspective', the criteria are: direct and indirect use values and non-use values, option use value, option non-use value, and bequest and existence non-use values. These criteria are described in Table 3.

Table 3. Descriptions of utilitarian criteria

Direct Use Value	The value ascribed to actual use of an ecosystem attribute eg. drinking water, food
Indirect Use Value	The value ascribed to the intangible benefits derived from a good or a service eg. assimilation of waste, or gas regulation
Option Use Value	The value ascribed to the option that goods or services are available for use if desired or needed, eg genetic resources for medicines
Option Non-use Value	The value ascribed to the option that a range of intangible ecosystem benefits are available should they be required, eg stabilisation services
Bequest Non-use value	The value ascribed to knowing that a range of intangible ecosystem benefits are preserved for future people, eg all attributes
Existence Non-use Value	The value of knowing that an ecosystem attribute exists, even though an individual may never use/access it, eg. biodiversity

Thank you all for persevering. After this round there is one more model (in round 4), then I will present the result and final weightings and sensitivities in the form of a valuation table with appropriate indicators as to the extent to which the ecosystem attributes are intact.

Questionnaire

Utilitarian

Please complete ALL questions and then select the *Submit* button at the bottom of the page.

51. The Earth Summit held in Rio de Janeiro in 1992 captured the spirit of a new environmentalism in which pragmatism was in full harmony with idealism. **True/False**

52. The Earth Summit produced a plan to achieve environmentally sustainable development (ESD) in the 21st C, known as Agenda 21. To what extent do you think this was compatible with the emerging global economy? **Text response**

53. To what extent do you think Agenda 21 or ESD is compatible with global inequities? **Text response**

54. To what extent do you think ESD is compatible with current levels of consumption? **Text response**

55. In some scenarios, to what extent is the status quo better preserved than trying to achieve ESD? **Text response**

56. The unprecedented levels of wealth due to economic growth are only experienced by a minority of people on earth, yet the risks are shared by all. **True/False**

57. Private sector monetary flow to developing countries is some three times the level of official aid, yet there is still little incentive to channel the funds into ESD. **True/False**

58. Individuals and enterprises should be encouraged to act more responsibly towards the environment through clear tax signals. **True/False**

59. Rational pricing structures can be far more effective tools to help the environment than subsidies and regulations. **True/False**

60. In round 2, 32% of the panellists answered false to the statement about biodiversity. Yet there are solid utilitarian reasons for preserving every scrap of biodiversity. Would you agree with a market-based regulatory framework for bio-prospecting? **Text response**

Appendix G

Preamble for round 4 and results of round 3 of the Delphi Inquiry

Results of round 4 and summary of the multiple criteria analysis

Greetings and welcome to the final round (round 4) of the Delphi.

The group again reached consensus in round 3. Kendall's W of the frequencies of true responses across the disciplines was 0.868 (*P<.000*). Neoclassical and environmental economists followed by natural resource managers and geographers, and ecologists and environmental scientists were the most consistent of the groupings. Exactly half of the panel answered 'false' to the suggestion that the Earth Summit in Rio in 1992 *"captured the spirit of a new environmentalism which was in full harmony with idealism".* 32% of the panel answered 'false' to *"rational pricing structures can be far more effective tools to help the environment than subsidies or regulations",* while all panellists answered 'true' to the question about private sector money flow to developing countries, and 96% 'true' to distributional effects and tax signals.

The full feedback of the panellists' responses was sent to the panel as an electronic mail attachment on July 30.

The second of the models in the multiple criteria analysis again produced an apparently varied response as to individual weightings of ecosystem attributes. This is indicative of the wide range of value judgements that can apply to human scaling of environmental attributes, yet statistical analysis of the panellist's set of responses proved to show significant concordance for most disciplines (Table 1).

Table 1. Results of Kendall's W for Model 2 (utilitarian perspective).

Discipline	Kendall's coefficient	Friedman's chi square	N	Significance
All disciplines	0.134	51.075	20	.000
Neoclassical Economists	0.289	27.465	5	.094
Environmental Economists	0.320	30.388	5	.047
Ecological Economists	0.147	25.129	9	.156
All Economists	0.175	63.054	19	.000
Geographers and Natural Resource Managers	0.464	70.571	8	.000
Ecologists	0.129	19.583	8	.420
Environmental Scientists	0.230	39.374	9	.004
All Natural Scientists	0.206	97.740	25	.000

A common use of Kendall's coefficient of concordance is to express the intensity of agreement among several rankings or as a measure of the agreement of rankings within blocks. The value of W may range from 0 (when the sum of ranks are equal and the sum of squares of the sum of ranks is 0, when there is no association), to 1 (when there is complete agreement among the ranking of all groups). To determine if a calculated sample W is significant, ie if it represents an association different from zero in concordance, the relationship between the Kendall coefficient of concordance (W) and the Friedman chi-square χ_r^2 is used:

$$\chi_r^2 = M(n\text{-}1)W.$$

where M = the number of variables, n = the size of the sample, and employing the table of critical values for χ_r^2.

All disciplines', all economists' and all scientists' groupings were significantly different to zero (no agreement), and the coefficient of variance for the weightings for each attribute ranged from 15.07 to 43.37 (mean 29.31). Accordingly the mean of all panellists' weightings for each attribute is again regarded as the appropriate measure of central tendency to carry forward to later steps in the analysis (Table 2).

Table 2. Means and normalised means taken the from panellist's weightings supplied for Model 2.

Attribute	Mean	Normalised Mean
Gas regulation (atmospheric composition)	15.45	5.79
Climate regulation (temperature, rainfall)	13.80	5.17
Disturbance regulation (ecosystem resilience)	12.45	4.66
Water regulation (hydrological cycle)	14.20	5.32
Erosion control and soil/sediment retention	13.10	4.91
Biological control (populations, pest/disease control)	12.85	4.81
Refugia (habitats for resident and transient populations)	12.80	4.79
Soil formation	12.75	4.78
Nutrient cycling and storage	13.45	5.04
Assimilation of waste and attenuation, detoxification	13.55	5.08
Purification (clean water, air)	14.30	5.36
Pollination (movement of floral gametes)	11.85	4.44
Biodiversity	14.25	5.34
Water supply (catchment)	14.75	5.53
Food production (that sustainable portion of GPP)	13.50	5.06
Raw materials (that sustainable portion of GPP, timber, fibre etc.)	13.95	5.23
Genetic resources (medicines, scientific and technological resources	14.05	5.26
Recreation opportunities (nature-based tourism)	13.25	4.96
Aesthetic, cultural and spiritual, (existence values)	12.95	4.85
Other non-use values (bequest, option and quasi option values)	9.70	3.63
Total	266.95	100.00

There are no questions in this round. Instead the third and last model will be introduced. Called the 'Balanced Sensitivity Perspective', it is the most important of the models. The sensitivities will be normalised to a total of 1 and used as a multiplier of the mean of the sum of the normalised means from model one and two. The criteria are: threats, risk, uncertainty, precaution, and ecosystem resistance and resilience. They have both negative and positive weights. These criteria are described in Table 3.

It is important to understand the difference between resistance and resilience in natural systems. To give an example, tropical rainforest is prone to damage from tropical cyclones, it is not very resistant as rainforest species are generally shallow-rooted, however it recovers very fast, it is very resilient. On the other hand, gas regulation as an ecosystem attribute is very resistant (it took from the time of the industrial revolution to reach the current levels of carbon dioxide in the atmosphere), but not at all resilient, with some scientists

saying that residence times for carbon dioxide in the atmosphere could exceed 500yrs.

Table 3. Descriptions of the balanced sensitivity criteria

	Max Weight	
Threats	-4	The extent to which the attribute is under threat from human activities or natural processes
Risk	-3	The extent to which the attribute is at risk
Uncertainty	-2	The level of uncertainty which exists with respect of the maintenance of this attribute
Precaution	-1	The need for precaution with respect to the attribute
Resistance	+7.5	The resistance (hardiness) of the attribute to perturbation by natural processes or human activities
Resilience	+7.5	The resilience of the attribute (ability to recover/time) after perturbation

Accordingly, a value judgement needs to be made for each attribute as to how great is the threat? (-4 or less), how much is it at risk? (-3 or less), what level of uncertainty exists? (-2 or less), and is there need for precaution? (-1 or 0). You will then need to decide how resistant the attribute is (+7.5 or less), and how resilient (+7.5 or less). For eg I weighted 'refugia': -4, -3, -2, -1, +2, +5, because it is endangered, has low resistance, but fairly high resilience. And I weighted 'water regulation (hydrological cycle)': -1, -1, 0, -1, +6, +7, because it is not at any great threat or risk but there is some need for precaution, and it is both resistant and resilient.

Thank you all for your time and effort. This is the last round where your input is required. Feedback from this round will present the final weightings of the ecosystem attributes after the sensitivity analysis. The weightings will be able to be applied in a valuation table to derive individual values for ecosystem goods and services, subject to a measure of their availability using biophysical and other indicators.

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Results of Round 4 and Summary of Results of the Multiple Model Multiple Criteria Analysis

There was no questionnaire in round 4. The panellists' responses to model three 'Balanced Sensitivity' presented in this round, again appeared to show a wide range of value judgements, particularly with regard to the resistance and resilience of the ecosystem attributes. However the level of agreement within and between all disciplines, with the exception of neoclassical economists, was highly significant. The sample size for neoclassical economists was small, but when analysed with environmental economists (also small), the level of concordance was highly significant. Overall, the highest coefficient of concordance was with the ecological economists. As four of the six criteria were negative, the mean of the panellists' weightings for each attribute was small, making it inappropriate to use the coefficient of variance as a statistical measure.

Table 1. Results of Kendall's coefficient of concordance for model three, 'Balanced Sensitivity'.

	Kendall's W	Friedman's Chi Square	N	Significance
All disciplines	0.295	139.938	25	.000
Neo-classical Economists	0.262	24.875	5	.165
Neo-classical & Environmental Economists	0.246	37.350	8	.007
Ecological Economists	0.479	72.847	8	.000
All Economists	0.331	100.752	16	.000
Geographers & Natural Resource Managers	0.338	44.949	7	.001
Ecologists	0.333	69.662	11	.000

Environmental Scientists	0.355	74.122	11	.000
All Natural Scientists	0.319	175.819	29	.000

The mean value of the attributes was sorted in ascending order, with the lowest value representing those attributes most endangered and with least resistance and resilience, and the highest, those least endangered and with the most resistance and resilience. The range of values was then used to convert all values to positive, with the lowest being one and the highest the most important, ie. the most at risk. These values were then normalised to a total of one for all attributes. The resulting decimals were then used as multipliers of the mean of weightings of models 1 and 2 to show the sensitivity of each attribute to threats, risk, uncertainty and precaution.

Summary of Results of the Multiple Model Multiple Criteria Analysis

Each of the three models presented had six different criteria, for which maximum weightings were supplied. Panellists were not obliged to assign the maximum weighting for the criteria to the attribute, ie. they could assign less if they wished. Criteria for the first model were anthropocentric, biophysical and economic, however the maximum weights were assigned to the anthropocentric criteria. The importance rankings for the three models are shown in table 2.

Table 2. Relative rankings of the attributes for each of the models

Attribute	Model 1	Model 2	Mean Models 1 & 2	Model 3	Final Importance Rank
Stabilisation Services					
Gas regulation (atmospheric composition)	1	1	1	8	5
Climate regulation (temperature, rainfall)	2	8	4	7	6
Disturbance regulation (ecosystem resilience)	10	18	13	9	9
Water regulation (hydrological cycle)	3	5	3	20	19
Erosion control and soil/sediment retention	11	13	12	3	3
Biological control (populations, pest/disease control)	14	15	15	5	7

Refugia (habitats for resident and transient populations)	13	16	14	2	2
Regeneration Services					
Soil formation	15	17	16	19	20
Nutrient cycling and storage (incl carbon sequestration)	5	11	7	15	13
Assimilation of waste and attenuation, detoxification	9	9	9	12	11
Purification (clean air, water)	7	3	5	10	8
Pollination (movement of floral gametes)	12	19	17	14	14
Biodiversity	6	4	6	1	1
Production of Goods					
Water supply (catchment)	4	2	2	13	12
Food production (that sustainable portion of GPP)	8	10	8	18	18
Raw materials (that sustainable portion of GPP, timber, fibre etc.)	17	7	11	16	16
Genetic resources (medicines, scientific and technological resources)	16	6	10	4	4
Life Fulfilling Services					
Recreation opportunities (nature-based tourism)	19	12	19	17	17
Aesthetic, cultural and spiritual (existence values)	18	14	18	6	10
Other non-use values (bequest, option and quasi-option values)	20	20	20	11	15

Model 1 results indicate that humans ascribe most value to a stable atmosphere and climate, clean air and water, the capacity of the environment to cycle and assimilate nutrients and pollutants, biodiversity and food production. Model 2 criteria consisted of direct and indirect use, non-use,

option, bequest and existence values. In this model, while the results are similar in many ways, climate was seen to be less important, and raw materials and genetic resources more important, which is consistent with the utilitarian perspective. Model three, which dealt with threats, risk, uncertainty, precaution and the resistance and resilience of ecosystems, provides a rather different perspective, with higher importance given to biodiversity, refugia, biological control, genetic resources, and erosion control and soil retention. These are clearly ecosystem attributes that are endangered in one way or another. Finally the result of the sensitivity analysis qualifies the results in terms of the non-pecuniary preference values ascribed by the panellists with the highest ranking given to attributes that are either endangered or essential for human life, or both. The top ten are given in Table 3. Interestingly an insight into human value preferences for the present as opposed to the future are also evidenced here, with attributes such as soil formation shown as least important. Clearly there is little humans can do to influence soil formation, which while obviously extremely important, is measured in thousands to tens of thousands of years.

Table 3. The ten ecosystem services ranked most important.

Attribute	Rank	Attribute	Rank
Biodiversity	1	Climate regulation	6
Refugia	2	Biological control	7
Erosion control/soil retention	3	Purification (clean air, water)	8
Genetic resources	4	Disturbance regulation	9
Gas regulation	5	Aesthetic, cultural & spiritual	10

Where to from here?

The production function of land or the *Usus Fructus per annum (UFpa),* which hosts an individual ecosystem service or attribute can be derived from the product of:

- the median unimproved capital value of land in a bioregion (MUV) in hectares[1]; and
- an appropriate market capitalisation rate (cr) (a % reflecting the level of protection and the degree of disturbance)[2].

The value of an individual ecosystem service or attribute can then be derived from the product of:

- the *Usus Fructus per annum (UFpa)*;

- the degree to which the ecosystem service (attribute) is intact (esi)[3]; and
- the final weighting (wt) of each attribute after the sensitivity analysis (a decimal)

See equations 1 & 2.

***UFpa* ($AUD/ha) = MUV ($AUD/ha) x cr (%)** *Equation 1*

V ($AUD per annum) = *UFpa* ($AUD/ha) x esi (%) x wt *Equation 2*

The sum of the values of all ecosystem services (attributes) present in a region multiplied by the area in hectares is the total value of the whole ecosystem.

[1]The unimproved value is the value assessed by State agencies charged with this responsibility for the purpose of levying rates and taxes.

[2]Capitalisation rates increase as the level of protection diminishes and either human or climatic disturbance increases. This incorporates the economic element of scarcity.

[3]Various methods are proposed to estimate the extent to which ecosystem services are intact, both on a landscape scale and for individual holdings.

Many thanks to all the panellists who participated in this study. More on point 3 above on this web-site at a later date. You will be advised by email.

Appendix H

Text responses from the round 1 questionnaire of the Delphi Inquiry

Results of Round 1

The group reached consensus. Kendall's Coefficient of Concordance (Kendall's W) of the frequency of 'true' answers from the seven disciplines represented was 0.814 (range 0-1), which (in terms of agreement) was highly significant (*P<.0001*).

However, some of the statements to do with anthropocentrism, for example:

"Anthopocentrism holds that only humans can have or ascribe intrinsic value, and as such all other features of the environment, whether living or non-living, can only have value through usefulness to humans",

raised some controversy, with some saying (to me by email) that while in essence they agreed with the statement, they did not agree with anthropocentrism. This led some respondents to answer 'false'.

However, 59% of the group answered 'true', with neo-classical economists and 'others' contributing the lowest score for 'true' (50%) and ecological; economists contributing the highest (82%)

The following statement:

"It follows that a feature of the environment or an ecosystem service must provide some utility to at least one human entity, otherwise it has no economic value",

resulted in a 70% group vote for 'true', with geographers the lowest score for 'true' (50%), and ecological economists again the highest (100%).

The statement (Q3):

"There is still a general lack of confidence in the outcomes of valuations of non-market goods and services in the environment, and uncertainties due to lack of knowledge of the resistance and resilience of ecosystems, irrespective of markets".

Resulted in a 100% group vote for true.

Other statements about past methodologies employed to value the environment had a mixed response, however an average of the responses for the 15 statements resulted in 85% of the group answering 'true', with the individual disciplines to the same order of response (82-89%). One exception was Q12:

"WTP is only useful in valuing a particular attribute of the environment eg. recreation, and is never areal, making it worthless to evaluate terrestrial ecosystems",

where 20% of environmental economists, 45% of ecological economists, 50% of neoclassical economists, geographers and ecologists, and 60% of natural resource managers and environmental scientists answered 'true'.

Statements to do with measurement and cash/dollar values for environmental goods also had a mixed response with a 56% average group vote for 'true' with the lowest 'true' vote from the geographers (48%) and the others ranging from 55-69%. Some notable high 'true' responses were for the statements:

"People express preferences for or against goods and services by buying them or not buying them", and

"Society can put a monetary value on a non-market good or service (unpriced), otherwise known as an intangible, under the right experimental conditions",

at 84% and 81% respectively. Conversely, some notable low 'true' responses were for the statements:

"Money is also regarded as the store of value (in terms of income and wealth), such that to express preferences or vote, it is assumed one must possess money", and

"There is an instinctive conviction that what cannot be measured may not exist"

at 35% and 27% respectively, with the two lowest responses coming from geographers (0 & 17% respectively).

The last statement (Q34):

"By developing a method to ascribe dollar values to ecosystem goods and services and thus finance conservation by way of establishing trading markets in them, natural resource utilisation can be made sustainable",

resulted in a group 'true' response of 59% with a range of from 50% (geographers and neoclassical economists) to 75% (environmental scientists).

Some interesting insights and comments were made in the text answers.

94% of the panellists agreed with the statement (Q19):

"Analysts that attempted to measure the intangibles (typically environmental goods and services) have been accused of trying to 'measure the immeasurable', and castigated for trying apply a money value to everything",

yet many defended the analyst's attempts:

"But it is a useful effort nevertheless. In some social systems, precious & life-supporting ecological processes have no value unless we estimate the cost of

a man-made engineered system than can provide the same ecosystem functions/services".

"But without an 'attempt' at doing so then economics (as the language of default) has become hegemoneous".

"But I think it is still worthwhile pursuing because it is better than nothing and we still operate in a economic framework system."

"But generally people don't 'value' ecosystem services or nature without some 'economic' or monetary estimates ".

"But one needs to try. There is also an opportunity cost approach where you look at the resources people commit to 'enjoying' natural resources".

"But the counter argument is that bringing everything into one denomination means that you can compare 'apples with apples' and make choices between two different things".

"Provided the exercise is placed in context, conditioned and the limitations explored and explained, the exercise has value in providing further insights, and knowledge...especially about what we do not or cannot understand".

But although unlikely we will ever be able to quantify environmental goods and services with a high degree of accuracy and precision (repeatability) going as far as we can towards it must surely be the goal of scientists, politicians etc."

"I wonder how the accusers (assuming they were well-intentioned) would react if told that the approach may be instrumental in preserving natural areas threatened by exploitation".

"Some people make this accusation, mostly those too stupid or too lazy to make the effort to try and make the measures".

Analysts have been accused of these things, however there are defences to the charges! I think the issue is that, even under anthropocentrism, these environmental goods and services often do have value to humans, and therefore, can at least be theor……." (theoretically valued).

"Analysis of these goods and services must be made in this day and age and the start must be made somewhere".

"Dollar values attached to goods and services of all kinds allows for a level playing field of comparison given clear delineation of assumptions and value judgements vs objective valuation".

Other panellists raised issues to do with difficulty in application, and the making of valuations relative to other goods and services rather than money,

as well as the ethical objections to such a practise, particularly across cultures.

62% of the panellists agreed with the statement (Q20):

"Some neo-classical economists and others are strongly critical of the practise of converting unpriced intangibles to a common monetary unit".

While 28% could or did not say. One panellist said *"No, neoclassical economists convert all values to money units".*

Some other comments were as follows:

Are there any good alternative methods of indicating value for ecosystem services?"

The monetary approach is surrounded by imprecision, but it has evolved as a reaction to the dominance of economic modelling of almost everything."

"Yes, because it is both unworkable and unnecessary!"

"Many approaches are needed, evolving over time as the 'science' of valuing ecosystem services grows".

"But an alternative is hard to find".

"They are purists and have no contact with the real world. Ignoring the intangibles in CBA is a real threat to sustainability of ecosystems and life-support systems".

"Very dangerous, it could over value or undervalue it".

"Yes, many economists do. The assumptions are often difficult, or bear no relationship to reality..... It is conceptually hard for many to understand how you can compare personal values of protected areas or a connection with nature".

"What do they propose instead? We need some yardstick to compare the value to humans of different entities, and money is the way most people make these comparisons (in western societies anyway)".

"As they would be if the analysis was that simple conversion, surely it is more complicated".

"There is an argument here. Unpriced intangibles have no scale - why is one habitat more significant than another, although these distinctions have already been made by land managers, eg. National Parks, World Heritage".

80% of panellists agreed with the following statement (Q28):

"An evaluation technique based on peoples' expressed preferences backed up by the ability to pay raises profound issues to do with anthropocentrism",

With 17% non-committal, and one saying "On the contrary, such a technique is based in anthropocentrism".

Other panellists raised issues to do with resources (ie. those with more cash/capital could control the bidding). Some other comments are as follows:

"Of course it does. Those whose preferences include valuing stuff that is priceless or outside the cash economy will not be noticed or valued. There are more paradigms than those of economists....and (happily) many humans have an understanding that not al……." (all?).

"Self-evidently true. It implies nothing is worthwhile unless it has value to humans".

"However, it is not actually committing them to pay, so their judgement may be different".

"Yes, certainly, the issue of preferences is strongly related to the anthropocentrism issue. I do think that some attempt to incorporate non-human values should be made, but do recognise that this will (or does) largely occur through non-economic measures".

87% of panellists agreed with the following statement (Q29):

"An evaluation technique based on peoples' expressed preferences raises profound issues to do with information variability across groups and effects of value aggregation within groups",

with 13% non-committal. Other comments where as follows:

"Different cultures value natural ecosystems differently, and for different reasons. City people and country people behave differently on the land".

"Correct. Even the difference between 'mean' and 'median' aggregated results can be immense".

"Yes, but not insurmountable!"

"This leads to a discussion about how 'perfect' your market is".

"Groups may receive different information or understand common information in different way irrespective of the technique employed. This is true also for marketed goods".

"Careful statistical analysis may overcome some of these problems. These problems are not just restricted to 'expressed preference' valuation methods".

"True...so that is why it is important in such an evaluation to employ a technique that deals with such variability".

"An evaluation model must be such that it determines a value across all groups and is not reliant on the views of either extreme".

"Yes. How does one aggregate between on individual and another? What happens when preferences "cancel each other out". Is majority value enough? When is something a majority (eg 51/49 split on a controversial issue like logging or damming a river".

"Absolutely. See above. To see the world only in terms of human values places humans at the centre and the judges of all things. Humans are but a part of the universe and their value systems must be put in context and decisions which flow from those values".

"Also true, but I presume the difficulties can be minimised by appropriate design and preliminary scene setting.

"True. I have seen some information showing that, for example, attitudes towards reptiles change depending on whether common names or scientific names are used. When common names, including "Royal", "King" etc are used, those species appear higher in list".

"Yes, WTP assumes much about the fickle nature of us weak humans. I may be very happy to pay heaps to reach Uluru but will not go to the effort to drive half an hour to the Oxley Wild Rivers NP. That does not make one or other more valuable".

"It does. Some would treat it as a statistical problem and might assume that it would come out in the wash of a normal distribution, an heroic and probably false hope".

There were many interesting and insightful responses to the open-ended question (Q30):

"What do you perceive are the most important issues in trying to ascribe monetary values for intangibles (unpriced goods), typically environmental goods and services?"

"Education and explanation of ecosystem goods & services as a human survival and quality of life argument. Demonstration (by dollar valuation) of human supporting and human threatening ecosystem performance".

"1. Information: it is almost always very contingent and imprecise, 2. Credibility: most people don't believe that everything can be reduced to a common numeraire".

"Biophysical data on current uses, and uses under different price and availability regimes".

"Inability to accurately price intangibles v economic benefits from development & generational factors, such as would a later generation ascribe different values & how to factor in the views of those concerned but not directly involved".

"Who decides? Who's money? Who's opinion/s? Time and place variables? Depth and breadth of diversity of cultures, economies, values etc."

"The more knowledge the better - that knowledge though needs to detail the major issues for a good and not every issue".

"Money exists and has a value now, whereas environment and social have massive delays in the value or damage they deliver. Hysteresis is the issue. And lack of knowledge of the linkages and multipliers".

"For people who want to ascribe monetary values to EG&S, a dollar value may not provide the outcome they wish. When a bio-system is endangered, a dollar value of its worth would not help".

"Lack of knowledge of the impacts of loss or degradation of ecosystem services both on and off-site".

"Money holds different values to different people, eg Kerry Packer versus Mr Average Aussie Citizen. Intangibles mean different things to different people so education/understanding is crucial".

"A broad cross-section of respondents to achieve a balanced 'community' view".

"Often it is not the actual value as if the intangible exists today but the loss of value if it does not or ceases to exist".

"How might we systematically be able to integrate non-quantitative values into decisions that we make?"

"Lack of agreement between different groups".

"Accuracy and precision and eliminating bias from development, conservation and political sources".

"Unique values are beyond dollar values and too ...?(important).... to leave to the marketplace".

"I think the most important things are about the academic process so things like rigour (good clear methodology, clear assumptions, repeatability etc) an idea of the authors belief systems (peer review is a good strategy... but if you want to prove conse……" (consensus?).

"Broad acceptance of the technique".

"Trying to value the priceless and reducing complexities and systems that are largely unfathomable to a monetary value.

"Comparability between groups responding to the survey, and avoiding the "frivolous responses" alluded to in qu. 10 above. Also, trying to build in to this model the rights of species other than humans to live on the planet".

"The difficulties of establishing the framework you are communicating in".

"1. the degree of disturbance to a natural system caused by a particular human development or activity 2. the amount of change, as measured by loss of biodiversity or alterations to natural processes, caused by a development or activity in a natural syste…..". (system).

"Information: people need to have some understanding of the goods and services, and why they are important."

"The intrinsic value of a habitat. How well it is already managed. How far from the beaten track these goods and services are. In terms of these services - the closer they are to main thoroughfares, then the lower priced they should be to encourage peo……" (people to?).

"Maximising objectivity where possible, minimising value-laden judgements and/or assumptions".

"A recognition that monetary value is not everything. Yes it is important but must not drive the debate".

"Information and understanding. Given how little science knows and the disjunctions in the transmission path from the frontiers of science to the populace, there are problems. Also new ideas from outside science can take a decade or more for recognition by……." (? scientists).

The open-ended question (Q31):

"If trading markets were established for ecosystem goods and services, how do you think this will enhance or finance conservation?"

would have sparked considerable debate in a face to face Delphi, with some panellists saying "to a great degree", "potentially very well" and others "trivial" and "they may not". Other insights were as follows:

"If set up correctly, eg with clearly defined property rights this could prove beneficial to avoiding exploitation of environmental goods and services. More research is needed though".

"It may distort them immensely, because well-capitalised players may tend to dominate the market for their own purposes/benefits".

“Firstly by putting the 'intangibles' on the agenda. Making them "visible". Getting them into the debate, news, research, etc.”

“If the price is right people will protect a resource &, or seek to acquire more of the resource”.

“It would help if the markets traded the right things. How do you handle salinity for example?”

“People would tend to preserve their ecosystem (e.g. cease clearing)”.

“It brings the value of the ecosystem goods and/or services into the real world of supply/demand, the real price that people will pay for those goods and/or services, etc.”

“This will greatly enhance and potentially finance conservation through a number of ways, most notably trading in carbon credits and possibly in 'biodiversity' credits.

“By mitigation of the impacts of a project, proposal or policy. Eg. Conservation and mitigation banking in the USA”.

“It might force those who 'manage/manipulate' the markets to get involved in coming up with a broadly acceptable valuation system”.

“Interest in carbon credits supports this idea”.

“By charging those that are inefficient”.

“Could reduce the gaps between different groups”.

“Would force acceptance of fundamental values and encourage legislated preservation of EG&S”.

“There are a number of ways that markets could enhance conservation but mostly it is indirect at least in the short run - over time demonstrate that conservation activities are just as productive as traditional agriculture - by pricing a good we get an……” (another ?comparable).

“It is another tool and could prove useful in purchasing or retaining significant properties to be managed as areas of conservation significance”.

“Placing a value on something is different from trading in it, and I hope we would not flog off our national parks. But we need to know the value of natural areas and of species so issues related to them can assume their rightful place in budget deliberati…..” (?deliberations).

“May give some leverage to conserve, maintain or reinstall some processes”.

"It could enhance, but not necessarily finance, conservation by altering decision in favour of the environment in some instances".

"When the cost of protecting the natural system makes the development or activity uneconomic the development or activity will not take place".

"Merely by holding back the tide a little. If at the very least, no net loss is achieved, then money re-circulated within the system will have made an impact".

"I am, despite the problems, an advocate of market systems because they provide fairly clear signals that can be acted upon quickly and they can appear fairer to those to whom they are directed because they are less discriminatory to regulatory enforcement".

The open-ended question (Q32):

"What possibility, do you think, exists for global business capturing markets for ecosystem goods and services?"

also caused considerable controversy with some panellists saying that it was "negligible, a non-issue", "low probability", and "a bad thing", "the concept horrifies me", while others "a high possibility and a good thing of course". Some other comments appear below:

"It is a problem that has repeated itself in so many other areas of commerce (eg. energy) that it is difficult to get romantic about the idea that business will do the right thing by the broader population".

"Diversity of intangibles and their geographic and national spread will mitigate against corporate control. This is a good thing unless it can be shown there are significant benefits from centralising control".

"Yes and possibly, but this would require very careful consideration of the implications. In particular, where there is scarcity of certain ecosystem goods and few market players".

"At this stage I am optimistic that it could contribute, but it should not be the sole mechanism. Like any market some regulation eg for anti-monopoly behaviour would be needed".

"There is a big market, and yes it's good. BP is doing it now".

"Slim possibility in Western nations. However, if you think about carbon trades, a global business will decrease the economic costs for Australia".

"Greater recognition of ecosystem services provided by less developed countries. May be a good thing if the result is greater global equity of wealth".

“If global business gets tied up with preserving the ecology, yes, it is a good thing”.

“This is already a reality with carbon trading arrangement as per the Kyoto Protocol. I believe this is a positive thing, provided the accounting procedures are fair and equitable (a big ask)”.

“A good possibility. Yes, if EG&S are on the balance sheets they will be protected”.

“Yes as it would assist in providing for better triple-bottom-line accounting”.

“With all things of this nature the acceptance will depend on perceived worth and the level of support or concessions made available”.

“Possibly, but will the markets look for efficiencies and devalue the environment?”

“I think there are mechanisms that allow for this possibility and in practice I think there are formal and informal markets for conservation activities (eg landswaps for conservation, paying more for "green energy" and "ethical investments".

“Very possible but need to evaluate whether this is what is needed ie morals vs the almighty $”.

“Globalisation like all economics is amoral. It is how monetary and economic policy is designed and employed and manipulated by governments and business that makes it a good or a bad thing”.

“The risk is growing with the increasing pre-eminence of US-style capitalism and privatisation. It would be a disaster. Global business exists to make a profit for its shareholders.

“Some opportunity through significant environmental issues, greenhouse etc., leading to major markets in carbon, global warming mitigation etc. Global business (assuming you mean multinational) are the real players and will bring the big money”.

“I think global businesses have little interest in protecting local environments. By and large they still see the global range of their resources being unlimited. If a local resource becomes depleted they can always move onto the next, e.g. oceanic fisheries”.

“I am not sure whether it would happen. It would be a bad thing if the markets do not lead to on-ground actions leading to environmental improvement. I can see that this might work regardless of whether global business captures the markets”.

”They will undoubtedly do it if it becomes a financial imperative. Not sure that it is a good thing, since markets have a habit of corrupting good ideas”.

A lot of panellists already answered this next question (Q33)

“If it is not a good thing, how do you think this can be avoided?”

or think it is a good thing, however some interesting ideas from the panellists are presented below:

“Small is beautiful, and probably more sustainable and reliable in the long run. Big business is based upon greed and profit. Small local businesses might be sustainable and promote high quality of life”.

“Don't lose Gov't control over such important goods. And continue to hope that Gov'ts are somewhat benevolent and not necessarily dominated by purely economic reasoning”.

“National governments should ensure they, or their domestic corporates, control intangibles to the exclusion of multi nationals”.

“Maintain Global Public assets”.

“An international (UN type? albeit with all of it's frailties) body - consultative, R&D, decision-making, advising, etc.”

“All markets need some monitoring, regulation etc.”

“This question presumes that there is a global market in EG&S. I do not think there is. However, if there was, it might be a good thing, since the premises upon which one wishes to conserve is for all humankind”.

“Democracy and effective, educated regulation. Laissez faire capitalism is dangerous”.

“Until ecosystem goods and services become subject to market (i.e. real world) forces and pressures, then they will continue to be given a nil or low value.

“By agreed international covenants to protect EG&S”

“I think one of the ways you can avoid this is carefully setting up the rules. I think we need to change the way we educate Australian children and adults to value the environment, for its own sake and then for the benefits it can give humans”.

“Many lessons to be learnt from past experiences eg carbon credits, the discussion about salinity and pollution credits”.

“It can be bad. It can and should be regulated to provide for a greater good and for the benefit of all, not just humans ie the global or local business must be made to practice in a biologically responsible manner that supports and enhances ecological pro……” (?processes)

“By not privatising ecosystems. By not allowing the products of evolution to be patented. By requiring business to have social and environmental charters and responsibilities”.

“It may be a good thing, but the drivers of change will probably have to come through legislation or litigation”.

“I wish I knew”.

Appendix I

Text responses from the round 3 questionnaire of the Delphi Inquiry

Feedback from Round 3

In response to the true/false questions, the group reached consensus. Kendall's W for the frequencies of 'true' responses between disciplines was 0.868, which was highly significant (*P<.000).* However, half of the panel responded 'false' to Q51:

"The Earth Summit held in Rio de Janeiro in 1992 captured the spirit of a new environmentalism which was in full harmony with idealism".

Answers to Qu's 56, 57, 58:

"The unprecedented levels of wealth due to economic growth are only experienced by a minority of people on earth, yet the risks are shared by all".

"Private sector money flow to developing countries is some three times the level of official aid, yet there is still little incentive to channel funds into ESD".

"Individuals and enterprises should be encouraged to act more responsibly towards the environment through clear tax signals".

Attracted 'true' responses of 96%, 100% & 96% respectively. Less convincing was the response to Q59:

"Rational pricing structures can be far more effective tools to help the environment than subsidies or regulations".

With only 68% of the panel answering 'true'.

Results of the text questions appear below.

In answer to question 52:

"The Earth Summit produced a plan to achieve environmentally sustainable development (ESD) in the 21st C, known as Agenda 21. To what extent do you think this was compatible with the emerging global economy?"

58% of respondents found that Agenda 21 was not at all compatible with the emerging global economy, a further 12% *'probably not'*, 12% *'can be', 'reasonably', or 'to some degree',* while 18% found that it was compatible at the time it was drawn up. Responses varied as follows:

"I think it was essentially at odds with the emerging global economy. ESD has now become a trite phrase reiterated at every chance by large companies who in the vast majority of cases merely pay lip service to the idea of anything remotely connected to tr…"

"No idea. I have been unable to find anyone who could tell me what Agenda 21 actually wants people to do to achieve sustainability. My readings indicate that Agenda 21 is a feel-good statement of principal and hope, but it does not specify any disc…"

"Likely to be conflicts".

"Agenda 21 sets the scene for the future in terms of ESD principles but is very idealistic in many ways. Globalisation, as it stands, tends to work against many aspects of Agenda 21, which is more about local communities taking control of the maintenance of, say, biodiversity".

"Produced a fair amount of idealism that is yet to be translated into much more than an opportunity for marketing gurus to work out how to sound like corporates agree but in fact continue to defy the same idealism".

"Agenda 21 was a ideal of environmentalists and bureaucrats seeking a green image. It is a fine concept that should be put into practice but the emerging global economy is itself not yet a real and stable entity. Economies are still driven by manipulation and domination with the thinking of the mid 20th C western values".

"I believe that ESD can be very compatible with globalisation and that globalisation could assist ESD since many environmental problems are global in nature. All what is required is global regulations so that multinationals are subject to western environmental legislation wherever they are located".

"Difficult to say how compatible it has been because many economies have been in transition and the over arching effects of the global economy pushed Governments to adopt policies/approaches for self interest. Its compatibility maybe is in the timing?"

"Not very compatible. It was idealistic as first attempts should be but had difficulty with big industry and with developing countries".

"The ideals and aims of the Earth Summit were good but in practice the world situation changed too rapidly and the plan was not flexible enough".

"Having only read principles of the plan I believe it is incompatible with the emerging global economy in its current form".

"Compatible to some degree but economic incentives and rewards are still in conflict with short term profit".

"It was reasonably compatible but the correlation was not 100%. It allows niche marketing of lifestyle and choice. There are issues of cause and effect and about the ability of locals to aggregate to determine global sustainability".

"Not yet compatible. Still a long way to go. Europe is moving faster in this domain than US, UK and Aus".

"Obviously incompatible as most multi-national businesses continue to burn fossil fuels, over-subscribe usage of freshwater supplies, support deforestation and cropland agriculture, and target profit rather than the 'public good'."

"The problem with these forums is that there is a lot of talk by 'eminent' people but in reality these people are not the doers of development. The other issue is one of the huge differential between the poor developing nations which have food supply as the

criterion and the so called developed nations which have $ as the criterion. I don't believe that A21 was able to merge the two.

"The issues are captured, there needs to be a much greater increase in appreciation of the role of ecosystems services, flora, ecology, spiritual values, etc., accompanying global economic priorities".

"The concepts are great but it will only be compatible with the so called emerging global economy if there is a higher weighting placed on working towards sustainable outcomes".

"It is highly compatible if implemented. The problem is still 10 years on that there is still very little achieved. It shows that even the compromises required to develop a 'pragmatic' less idealistic (hence my false to Q51) agenda does not mean it will be accepted by conservative governments and businesses".

"Probably as compatible as politically possible. May have achieved more than subsequent rounds achieved or could achieve for the time being because of hardened positions".

A lot of responses to Question 53 were qualified, although of those that did answer:

"To what extent do you think Agenda 21 or ESD is compatible with global inequalities?"

93% thought Agenda 21 and ESD to be not compatible with global inequalities. Some insights were as follows:

"ESD has little to do with global inequalities, since it does not try to address the reasons why some people or countries have a high/low standard of living/quality of life".

"ESD, in theory, addresses global inequalities because of its main underlying principles. In practice, global inequality (both economically and environmentally) is increasing, rather than decreasing".

"They are probably best described as mutually exclusive. They appear to have disparate targets".

"The stated objectives of Agenda 21 are mindful of global inequities and aims to address these. Publicly (in the media) the concept of ESD and its objectives appears to be compatible with global inequities on a small scale but some very large scale situations still exist where the local economic conditions or foreign corporate influence mean that ESD is ignored".

"Extractive resources are in LDCs while their consumption are in DC. In order to extract the resources (bought at price P1 say LDCs become poorer because 1). Resources are not replaced even when MNCs could (e.g. timber). 2). Profits go back to DCs. 3). LDCs buy finished products from DCs and finished products more expensive than sale of raw material therefore LDCS get poorer. 4). If LDCs adopt ESD then they cannot develop

since they cannot purchase expensive HI-tech that could get them out therefore ESD is compatible with inequality".

"Agenda 21 is far from compatible with global inequalities. But what do you expect we live in an ever complexing world. It's dynamic. I can not see A21 can ever be compatible, it's a big ask. If I was to give a rating I would say 35% compatibility".

"Not very compatible. The trouble is the developed countries have exploited their resources and may be able to consider alternative ways to maintain their standard of living while developing countries are being asked to accept constraints on resource development that will adversely impact on their economic outcomes".

"ESD is more likely to be achieved on a global scale as these inequalities are made smaller"

"Current global inequalities are far too wide for agreement on and implementation of an international approach to ESD".

"The inequalities are between E and W and in some cases between N & S. The have-nots are in a diagonal global belt from Asia through Africa to Sth America. Agenda 21 needs major structural assistance to work in the 3rd world. Debt forgiveness would be a start".

"Could significantly entrench inequality. Those with capacity (social, economic and ecological) to regenerate and move to sustainable practices may be able to move forwards. On the other hand starting from a low base dramatic improvement can be made - see recent stuff on Ethiopia and 10-15 years since 'live aid' and the local sustainability that had developed there".

"Theoretically compatible but in reality the underdeveloped countries are still at the mercy of the developed world via debt and the world bank etc."

"Applications need to be context cultural and locally relevant specific and egalitarian".

"I am not sure that it really helps towards overcoming global inequalities unless those at the 'more privileged' end of the spectrum are prepared to make allowances for the 'less privileged'. As a wider society we need to establish sustainable benchmarks which may be lower than the 'more privileged' expect".

"In principle the focus on intra and intergenerational equities is positive and its good to see 'intra' getting more attention in Australia. Again it seems to be more in principle than in practice...there is not enough willingness to change developed country lifestyles to address the inequities".

"I have not been engaged in this debate to any extent and this is a very big question to answer in a paragraph. At one level the answer is yes because there are influences ranged against ESD in both affluent and less affluent countries they take different forms and there may also be pressures for ESD embedded in cultural values of some less affluent societies. The desire for personal mobility and the associated energy costs are the problem. Air travel is the sleeper it uses a lot of fuel".

Question 54 then went on to ask:

"To what extent do you think ESD is compatible with current levels of consumption?"

and 74% responded that it was not very or not at all compatible. The remainder argued that it was change that was required.

"ESD calls for more conservative consumption of environmental goods and services, by placing a greater emphasis on local sustainable use of renewable resources and responsible use of non-renewables".

"Reduced consumption through improved efficiency or waste minimisation coupled with continually improving production (ESD) techniques will increase compatibility".

"It's not the levels of consumption that are important but the types. e.g. producing some types of foods is less healthy for the environment than others".

"Not at all in the developed countries. ESD needs changes in per capita consumption changes in materials and processes changes in recycling".

"Reasonably - more a question in changing the composition of consumption rather than absolute levels".

"ESD as practised might reduce degradation but will not stop it or reverse it. High intensity production and the agricultural techniques needed to achieve it are the main problems".

"Current levels are driven more by cost. Still living and working in an old paradigm. The whole way of doing business needs to change to really affect consumption trends".

"I am not sure that it is. However high consumption does not have to be equated with success and so we need to re-evaluate our societal goals".

"It is too process based and there is not sufficient focus on achieving specific targets...while there is some progress to improving efficiencies in production and there is increasing knowledge among consumers and eco-labelling etc etc ESD is not doing enough to inspire the types of changes I believe are required. (eg Factor 10 is now being talked about instead of Factor 4! (eg Wuppertal Institute Rocky Mountain Institute line of argument)".

"See Q53 energy sources for transport and climate control for personal comfort are obvious areas of incompatibility. The sustainability of agricultural practices that require high levels of inputs to farming may become a problem as average calorie and protein intake of an enlarged population approaches western averages. World experience with large-scale commercial farming is only 150 years".

Question 55 was to do with the status quo:

“In some scenarios, to what extent is the status quo better preserved than trying to achieve ESD?”

and caused some consternation, with most answering *‘no extent’,* however it was not as straightforward as that.

“Those who have faith in human innovation and technology would argue that humans will ultimately solve the current environment crisis, and that market forces will dictate when and where these new technologies will be introduced”.

“Only if the status quo is an environmentally and economically sustainable practice already otherwise I can think of no reason not to try and achieve ESD”.

“What can you preserve in Status Quo? You can not stop the Earth. Systems move, countries evolve, places die, people move. In answering the question - simplicity to monitor and manage a status quo planet”.

“Both create difficulties for developing countries which must be allowed to develop”.

“Maintaining the status quo is the easier do nothing option. ESD is the only choice if we are prepared to act for the benefit of future generations. ESD might be impossible under political pressures within a number of countries”.

“Where population growth is low, consumption per capita is low, and pollution is low, the status quo is defensible even if biodiversity is decreasing”.

“It is better to preserve what is left of our natural landscapes than to convert them to agriculture based on ESD principles. The problem is the D in ESD”.

“When compensation is not paid when rights are being taken away unilaterally. When the status quo is already sustainable, maybe using existing power generation until a new alternative (green) is built. There is excess capacity in the existing system so long as additional funds are put into developing a better alternative in the future. Could the desire for democracy be more important than the need for ESD?”

“Status quo is only better when the activities carried out under the banner of ESD are purely politically/economically expedient and not really forwarding the action of ESD”.

“Virtually none. Human beings aspire to certain levels of comfort and well being, with the western world's standard of living/quality of life now the goal of the 4 billion people living elsewhere on the planet. It would be morally wrong for those who have to preclude the rights of the have-nots to a similar standard of living”.

“ 'Status quo' would seem to imply maintaining an increasing trend (in consumption, etc.) rather than a stable one, so there appears to be only one outcome. So attempting to target some form of ESD is probably better than aiming for 'status quo' “.

“The status quo (business as usual) is not sustainable in the next several decades. Ecological disaster, financial and economic collapse and cultural/social unrest are already resulting from unsustainable human business”.

"There would be isolated pockets throughout the world where currently your statement might be correct but basically the world is not static so those locations would need to be preparing themselves for change (be it climate economic health etc). Basically ESD is worth striving for in someway as it prepares peoples for change".

"My view is we should aim to achieve overall ESD which probably means that there needs to be ESD in all the subsets that make up the whole".

"Seeking to achieve sustainable water extraction: case in point (broader Water Reform agenda in Australia has lots of these issues but this is just one): the notion of 'balancing' of ecological social and environmental factors is causing many inconsistencies and blockages which will be harder to 'correct' and are inconsistent with ESD. Water use levels are not being set on best available science (which is patchy but some good stuff does exist: look at Gwydir in NSW for example)...targets are being limited based on expected economic and social impacts which are not necessarily going to eventuate...while I have empathy for those who may suffer impacts the focus would be better on how to ameliorate these impacts. At present the precautionary principle is not being applied on the grounds of social and economic impact but with very little if any substantiation of claims...."

"My view is that ESD can only be approached incrementally. I would not assume that any scenario could not be improved without some step towards ESD at the same time. A comment on Q56 below we seem to be a situation where wealth in dollar terms is not a ready measure of lifestyle when average incomes in Seoul are similar to Melbourne and affluent lifestyles in say Cape Town are achieved at a 12th the cost of similar lifestyle in London. The minority is larger than we might assume".

Finally, I asked (Qu 60):

"In round 2, 32% of the panellists answered false to the statement about biodiversity. Yet there are solid utilitarian reasons for preserving every scrap of biodiversity. Would you agree with a market-based regulatory framework for bio-prospecting?"

A number of the panellists had strong views either way and a number of others qualified their answers. Overall 52% said yes. 24% said a qualified yes, and 24% said no. Some comments were as follows:

"Yes, biodiversity need to be given value in the same way that we value other natural resources, such as oil, coal and timber".

"I agree strongly with a regulatory framework for bio-prospecting but cannot decode whether it should be market based or governmental or ethics committee etc. I think of equal numbers of pros and cons for each".

"No, the planet is a living thing that evolves within its own time scale. Man has influenced the planetary systems however a regulatory framework can not be expected to preserve every scrap of biodiversity in a system too complex for humans to understand. And possibly never will".

"Until there is an accepted market system which can effectively regulate it is difficult to see how other regulatory frameworks can be avoided. I would prefer a market mechanism but do not think we can afford the damage that will be done while we are waiting for it".

"Yes. Trials need to be made to test such mechanisms because of the dire state of many ecosystems. This is one method that could work but may need to be accompanied by non-market based means. It will probably be a situation of horses for courses".

"A market-based regulatory framework could work for bio-propecting. The patenting system should be revised so as to avoid indefinite locking up of information on natural products or inflating the prices of such products particularly in the production of pharmaceuticals and pesticides. This should especially apply when information on a natural resource is obtained from indigenous or lay people.

"Framework needs financial incentives and controls in patenting and profiteering together with limits on harvest levels and techniques".

"Strongly disagree with your "every scrap of biodiversity" assertion. There is irrefutable evidence that some (which??) biodiversity is redundant! A market based framework for bio-prospecting MAY be worth trying but it is neither necessary nor sufficient!"

"No. I believe the products of natural evolution should be the property of everyone and the benefits of bioprospecting should not be appropriated by private corporations".

"Setting the ground rules is a good idea but not so sure that it needs to be market based. Issues like intellectual ownership and returns to those with the knowlege whether cultural or scientific need careful rules and funding. Bioprospecting is about taking a risk- looking for something new and then developing the idea/resource. This is not really any different to other business opportunities. However there are issues about access to quality of life enhancers that could end up in private hands to the detriment of society as whole (eg cost of AIDS drugs based in bio-prospecting research). I think a case could be made for government supported research with the returns going to conservation/management of the new-found resource".

"I would PROVIDED that each and every institution/business involved is clear about the ethics of what they are doing. Training and contractual arrangements need to be in place to ensure that the activities don't end up producing worse problems for humanity and for biodiversity".

"No. A market based bio-prospecting framework is very unlikely to preserve biodiversity for future generations".

"No. It might reflect my knowledge about bio-prospecting but I feel it too early for market based mechanisms to be used in bio-prospecting. A flexible/dynamic regulatory environment would be preferable at present".

"All biodiversity needs to protected as it plays a vital and often as yet not-understood role in global ecological processes".

"Yes as long as the regulatory framework is really focussed at supporting the principle of biodiversity".

"The largest problem for loss of 'biodiversity' in Amazonian rainforest is that the people who cut down forests do not receive benefits of bioprospecting sufficient to release them from the need to clear land. There can be no solution without addressing this 'ground-level' (and very basic) problem. If this is part of 'market-based regulatory framework' then yes. Phyllis Coley is the first person I know to have attempted to address this problem in a practical realistic manner".

"I would need to know more. I would have argued True on the statement on biodiversity but would need to have a thorough analysis of the costs/benefits/risks etc associated with bioprospecting before I supported it. Also question 58 and 59 make me feel a bit contradictory but the issue is a suite of options seems to be the best option and different options have different pros and cons...what appears to be needed is a better understanding of the conditions in which a particular option works well and not so well...one concern I have and I have not yet reached an answer is how many options do we need to develop (I'm not really seeking a number!) but if a suite is needed what is the composition of that suite: and is it better to have a suite of general instruments which can cover most eventualities or do we develop particular instruments very strongly focussed an a required outcome in a specific case (eg as the US Nature Conservancy does with some of its activities eg conservation beef?)".

"Took a strict interpretation of the question. I am not sure that the sciences know whether all ecosystems would gain by increased biodiversity and some less biodiverse may just as productive as more biodiverse systems. There is an ambiguity in the question. In answer to the question – no, I don't think a market would be feasible, it would be too hard to price so regulation would be the approach".

Results of the panellists' weightings of the 'Utilitarian' model (model 2) will be given on the webpage at the start of round 4.

Thank you all for your input, I think you will agree that there is some very interesting comments here, and some of the content indicative of the diversity of value judgements when it comes to issues to do with the environment.

Appendix J

Valuation tables for each of the tenure categories in the Wet Tropics World Heritage Area

TENURE CATEGORY. CORE PRECINCT: NATIONAL PARKS WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		6.50%	low	high		92% intact	99% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 247.65	92	99	0.069	$ 15.72	$ 16.92	$ 4,492,130.56	$ 4,833,923.10
Climate regulation (temperature, rainfall)				Yes	$ 247.65	92	99	0.068	$ 15.49	$ 16.67	$ 4,427,027.22	$ 4,763,866.25
Disturbance regulation (ecosystem resilience)				Yes	$ 247.65	92	99	0.055	$ 12.53	$ 13.48	$ 3,580,683.78	$ 3,853,127.11
Water regulation (hydrological cycle)				Yes	$ 247.65	92	99	0.011	$ 2.51	$ 2.70	$ 716,136.76	$ 770,625.42
Erosion control and soil/sediment retention				Yes	$ 247.65	92	99	0.073	$ 16.63	$ 17.90	$ 4,752,543.93	$ 5,114,150.53
Biological control (populations, pest/disease control)				Yes	$ 247.65	92	99	0.063	$ 14.35	$ 15.45	$ 4,101,510.51	$ 4,413,581.96
Refugia (habitats for resident and transient populations)				Yes	$ 247.65	92	99	0.086	$ 19.59	$ 21.08	$ 5,598,887.37	$ 6,024,889.67
Regeneration Services												
Soil formation				Yes	$ 247.65	92	99	0.010	$ 2.28	$ 2.45	$ 651,033.41	$ 700,568.57
Nutrient cycling and storage				Yes	$ 247.65	92	99	0.039	$ 8.89	$ 9.56	$ 2,539,030.32	$ 2,732,217.41
Assimilation of waste and attenuation, detoxification				Yes	$ 247.65	92	99	0.051	$ 11.62	$ 12.50	$ 3,320,270.42	$ 3,572,899.69
Purification (clean water, air)				Yes	$ 247.65	92	99	0.058	$ 13.21	$ 14.22	$ 3,775,993.81	$ 4,063,297.68
Pollination (movement of floral gametes)				Yes	$ 247.65	92	99	0.036	$ 8.20	$ 8.83	$ 2,343,720.29	$ 2,522,046.84
Biodiversity				Yes	$ 247.65	92	99	0.099	$ 22.56	$ 24.27	$ 6,445,230.81	$ 6,935,628.80
Production of Goods												
Water supply (catchment)				Yes	$ 247.65	92	99	0.043	$ 9.80	$ 10.54	$ 2,799,443.68	$ 3,012,444.83
Food production (that sustainable portion of GPP)				Yes	$ 247.65	92	99	0.024	$ 5.47	$ 5.88	$ 1,562,480.20	$ 1,681,364.56
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 247.65	92	99	0.029	$ 6.61	$ 7.11	$ 1,887,996.90	$ 2,031,648.84
Genetic resources (medicines, scientific and technological resources				Yes	$ 247.65	92	99	0.073	$ 16.63	$ 17.90	$ 4,752,543.93	$ 5,114,150.53
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 247.65	92	99	0.025	$ 5.70	$ 6.13	$ 1,627,583.54	$ 1,751,421.41
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 247.65	92	99	0.054	$ 12.30	$ 13.24	$ 3,515,580.44	$ 3,783,070.26
Other non-use values (bequest, option and quasi option values)				Yes	$ 247.65	92	99	0.033	$ 7.52	$ 8.09	$ 2,148,410.27	$ 2,311,876.27
								0.999	$ 227.61	$ 244.93	$ 65,038,238.13	$ 69,986,799.73
									92% intact	99% intact		
				TEV ($AUDpa)			**Hectares**	**285,744**	**$ 65,038,238.13**	**$ 69,986,799.73**		
							(Ref WTMA GIS)					

APPENDIX 'B' TENURE CATEGORY: ~ STATE FOREST CONSERVATION AREA WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		7%	Low	High		84% intact	92% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 266.70	84	92	0.069	$ 15.46	$ 16.93	$ 5,368,567.96	$ 5,879,860.15
Climate regulation (temperature, rainfall)				Yes	$ 266.70	84	92	0.068	$ 15.23	$ 16.68	$ 5,290,762.63	$ 5,794,644.79
Disturbance regulation (ecosystem resilience)				Yes	$ 266.70	84	92	0.055	$ 12.32	$ 13.50	$ 4,279,293.31	$ 4,686,845.05
Water regulation (hydrological cycle)				Yes	$ 266.70	84	92	0.011	$ 2.46	$ 2.70	$ 855,858.66	$ 937,369.01
Erosion control and soil/sediment retention				Yes	$ 266.70	84	92	0.073	$ 16.35	$ 17.91	$ 5,679,789.30	$ 6,220,721.61
Biological control (populations, pest/disease control)				Yes	$ 266.70	84	92	0.063	$ 14.11	$ 15.46	$ 4,901,735.97	$ 5,368,567.96
Refugia (habitats for resident and transient populations)				Yes	$ 266.70	84	92	0.086	$ 19.27	$ 21.10	$ 6,691,258.62	$ 7,328,521.35
Regeneration Services												
Soil formation				Yes	$ 266.70	84	92	0.010	$ 2.24	$ 2.45	$ 778,053.33	$ 852,153.65
Nutrient cycling and storage				Yes	$ 266.70	84	92	0.039	$ 8.74	$ 9.57	$ 3,034,407.98	$ 3,323,399.22
Assimilation of waste and attenuation, detoxification				Yes	$ 266.70	84	92	0.051	$ 11.43	$ 12.51	$ 3,968,071.97	$ 4,345,983.59
Purification (clean water, air)				Yes	$ 266.70	84	92	0.058	$ 12.99	$ 14.23	$ 4,512,709.30	$ 4,942,491.14
Pollination (movement of floral gametes)				Yes	$ 266.70	84	92	0.036	$ 8.07	$ 8.83	$ 2,800,991.98	$ 3,067,753.12
Biodiversity				Yes	$ 266.70	84	92	0.099	$ 22.18	$ 24.29	$ 7,702,727.95	$ 8,436,321.09
Production of Goods												
Water supply (catchment)				Yes	$ 266.70	84	92	0.043	$ 9.63	$ 10.55	$ 3,345,629.31	$ 3,664,260.67
Food production (that sustainable portion of GPP)				Yes	$ 266.70	84	92	0.024	$ 5.38	$ 5.89	$ 1,867,327.99	$ 2,045,168.75
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 266.70	84	92	0.029	$ 6.50	$ 7.12	$ 2,256,354.65	$ 2,471,245.57
Genetic resources (medicines, scientific and technological resources				Yes	$ 266.70	84	92	0.073	$ 16.35	$ 17.91	$ 5,679,789.30	$ 6,220,721.61
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 266.70	84	92	0.025	$ 5.60	$ 6.13	$ 1,945,133.32	$ 2,130,384.11
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 266.70	84	92	0.054	$ 12.10	$ 13.25	$ 4,201,487.97	$ 4,601,629.68
Other non-use values (bequest, option and quasi option values)				Yes	$ 266.70	84	92	0.033	$ 7.39	$ 8.10	$ 2,567,575.98	$ 2,812,107.03
								0.999	$ 223.81	$ 245.12	$ 77,727,527.49	$ 85,130,149.16
									84% intact	92% intact		
				TEV ($AUDpa)			**Hectares**	**347,300**	**$ 77,727,527.49**	**$ 85,130,149.16**		
							(Ref WTMA GIS)					

TENURE CATEGORY: ~ TIMBER RESERVES CONSERVATION AREA WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		7.5%				66% intact	84% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 285.75	66	84	0.069	$ 13.01	$ 16.56	**$ 965,092.26**	**$ 1,228,299.25**
Climate regulation (temperature, rainfall)				Yes	$ 285.75	66	84	0.068	$ 12.82	$ 16.32	**$ 951,105.42**	**$ 1,210,497.81**
Disturbance regulation (ecosystem resilience)				Yes	$ 285.75	66	84	0.055	$ 10.37	$ 13.20	**$ 769,276.44**	**$ 979,079.11**
Water regulation (hydrological cycle)				Yes	$ 285.75	66	84	0.011	$ 2.07	$ 2.64	**$ 153,855.29**	**$ 195,815.82**
Erosion control and soil/sediment retention				Yes	$ 285.75	66	84	0.073	$ 13.77	$ 17.52	**$ 1,021,039.64**	**$ 1,299,505.00**
Biological control (populations, pest/disease control)				Yes	$ 285.75	66	84	0.063	$ 11.88	$ 15.12	**$ 881,171.20**	**$ 1,121,490.62**
Refugia (habitats for resident and transient populations)				Yes	$ 285.75	66	84	0.086	$ 16.22	$ 20.64	**$ 1,202,868.62**	**$ 1,530,923.70**
Regeneration Services												
Soil formation				Yes	$ 285.75	66	84	0.010	$ 1.89	$ 2.40	**$ 139,868.44**	**$ 178,014.38**
Nutrient cycling and storage				Yes	$ 285.75	66	84	0.039	$ 7.36	$ 9.36	**$ 545,486.93**	**$ 694,256.10**
Assimilation of waste and attenuation, detoxification				Yes	$ 285.75	66	84	0.051	$ 9.62	$ 12.24	**$ 713,329.06**	**$ 907,873.36**
Purification (clean water, air)				Yes	$ 285.75	66	84	0.058	$ 10.94	$ 13.92	**$ 811,236.98**	**$ 1,032,483.42**
Pollination (movement of floral gametes)				Yes	$ 285.75	66	84	0.036	$ 6.79	$ 8.64	**$ 503,526.40**	**$ 640,851.78**
Biodiversity				Yes	$ 285.75	66	84	0.099	$ 18.67	$ 23.76	**$ 1,384,697.60**	**$ 1,762,342.40**
Production of Goods												
Water supply (catchment)				Yes	$ 285.75	66	84	0.043	$ 8.11	$ 10.32	**$ 601,434.31**	**$ 765,461.85**
Food production (that sustainable portion of GPP)				Yes	$ 285.75	66	84	0.024	$ 4.53	$ 5.76	**$ 335,684.27**	**$ 427,234.52**
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 285.75	66	84	0.029	$ 5.47	$ 6.96	**$ 405,618.49**	**$ 516,241.71**
Genetic resources (medicines, scientific and technological resources				Yes	$ 285.75	66	84	0.073	$ 13.77	$ 17.52	**$ 1,021,039.64**	**$ 1,299,505.00**
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 285.75	66	84	0.025	$ 4.71	$ 6.00	**$ 349,671.11**	**$ 445,035.96**
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 285.75	66	84	0.054	$ 10.18	$ 12.96	**$ 755,289.60**	**$ 961,277.67**
Other non-use values (bequest, option and quasi option values)				Yes	$ 285.75	66	84	0.033	$ 6.22	$ 7.92	**$ 461,565.87**	**$ 587,447.47**
								0.999	$ 188.41	$ 239.79	**$ 13,972,857.56**	**$ 17,783,636.90**
									66% intact	84% intact		
				TEV ($AUDpa)			**Hectares**	**74,163**	**$ 13,972,857.56**	**$ 17,783,636.90**		
							(Ref WTMA GIS)					

TENURE CATEGORY: ~ VARIOUS RESERVES AND DAMS WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		7.5%				66% intact	79% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 285.75	66	79	0.069	$ 13.01	$ 15.58	$ 132,824.95	$ 158,987.44
Climate regulation (temperature, rainfall)				Yes	$ 285.75	66	79	0.068	$ 12.82	$ 15.35	$ 130,899.95	$ 156,683.27
Disturbance regulation (ecosystem resilience)				Yes	$ 285.75	66	79	0.055	$ 10.37	$ 12.42	$ 105,874.96	$ 126,729.12
Water regulation (hydrological cycle)				Yes	$ 285.75	66	79	0.011	$ 2.07	$ 2.48	$ 21,174.99	$ 25,345.82
Erosion control and soil/sediment retention				Yes	$ 285.75	66	79	0.073	$ 13.77	$ 16.48	$ 140,524.95	$ 168,204.10
Biological control (populations, pest/disease control)				Yes	$ 285.75	66	79	0.063	$ 11.88	$ 14.22	$ 121,274.95	$ 145,162.44
Refugia (habitats for resident and transient populations)				Yes	$ 285.75	66	79	0.086	$ 16.22	$ 19.41	$ 165,549.94	$ 198,158.26
Regeneration Services												
Soil formation				Yes	$ 285.75	66	79	0.010	$ 1.89	$ 2.26	$ 19,249.99	$ 23,041.66
Nutrient cycling and storage				Yes	$ 285.75	66	79	0.039	$ 7.36	$ 8.80	$ 75,074.97	$ 89,862.47
Assimilation of waste and attenuation, detoxification				Yes	$ 285.75	66	79	0.051	$ 9.62	$ 11.51	$ 98,174.96	$ 117,512.46
Purification (clean water, air)				Yes	$ 285.75	66	79	0.058	$ 10.94	$ 13.09	$ 111,649.96	$ 133,641.62
Pollination (movement of floral gametes)				Yes	$ 285.75	66	79	0.036	$ 6.79	$ 8.13	$ 69,299.97	$ 82,949.97
Biodiversity				Yes	$ 285.75	66	79	0.099	$ 18.67	$ 22.35	$ 190,574.93	$ 228,112.41
Production of Goods												
Water supply (catchment)				Yes	$ 285.75	66	79	0.043	$ 8.11	$ 9.71	$ 82,774.97	$ 99,079.13
Food production (that sustainable portion of GPP)				Yes	$ 285.75	66	79	0.024	$ 4.53	$ 5.42	$ 46,199.98	$ 55,299.98
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 285.75	66	79	0.029	$ 5.47	$ 6.55	$ 55,824.98	$ 66,820.81
Genetic resources (medicines, scientific and technological resources				Yes	$ 285.75	66	79	0.073	$ 13.77	$ 16.48	$ 140,524.95	$ 168,204.10
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 285.75	66	79	0.025	$ 4.71	$ 5.64	$ 48,124.98	$ 57,604.14
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 285.75	66	79	0.054	$ 10.18	$ 12.19	$ 103,949.96	$ 124,424.95
Other non-use values (bequest, option and quasi option values)				Yes	$ 285.75	66	79	0.033	$ 6.22	$ 7.45	$ 63,524.98	$ 76,037.47
								0.999	$ 188.41	$ 225.52	$ 1,923,074.27	$ 2,301,861.63
									66% intact	79% intact		
				TEV ($AUDpa)			**Hectares**	**10,207**	**$ 1,923,074.27**	**$ 2,301,861.63**		
							(Ref WTMA GIS)					

TENURE CATEGORY: ~ UNALLOCATED STATE LAND WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		7.75%				56% intact	72% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 295.28	56	72	0.069	$ 11.41	$ 14.67	$ 690,445.04	$ 887,715.05
Climate regulation (temperature, rainfall)				Yes	$ 295.28	56	72	0.068	$ 11.24	$ 14.46	$ 680,438.59	$ 874,849.61
Disturbance regulation (ecosystem resilience)				Yes	$ 295.28	56	72	0.055	$ 9.09	$ 11.69	$ 550,354.74	$ 707,598.95
Water regulation (hydrological cycle)				Yes	$ 295.28	56	72	0.011	$ 1.82	$ 2.34	$ 110,070.95	$ 141,519.79
Erosion control and soil/sediment retention				Yes	$ 295.28	56	72	0.073	$ 12.07	$ 15.52	$ 730,470.84	$ 939,176.79
Biological control (populations, pest/disease control)				Yes	$ 295.28	56	72	0.063	$ 10.42	$ 13.39	$ 630,406.34	$ 810,522.44
Refugia (habitats for resident and transient populations)				Yes	$ 295.28	56	72	0.086	$ 14.22	$ 18.28	$ 860,554.69	$ 1,106,427.45
Regeneration Services												
Soil formation				Yes	$ 295.28	56	72	0.010	$ 1.65	$ 2.13	$ 100,064.50	$ 128,654.36
Nutrient cycling and storage				Yes	$ 295.28	56	72	0.039	$ 6.45	$ 8.29	$ 390,251.54	$ 501,751.98
Assimilation of waste and attenuation, detoxification				Yes	$ 295.28	56	72	0.051	$ 8.43	$ 10.84	$ 510,328.94	$ 656,137.21
Purification (clean water, air)				Yes	$ 295.28	56	72	0.058	$ 9.59	$ 12.33	$ 580,374.09	$ 746,195.26
Pollination (movement of floral gametes)				Yes	$ 295.28	56	72	0.036	$ 5.95	$ 7.65	$ 360,232.19	$ 463,155.68
Biodiversity				Yes	$ 295.28	56	72	0.099	$ 16.37	$ 21.05	$ 990,638.53	$ 1,273,678.11
Production of Goods												
Water supply (catchment)				Yes	$ 295.28	56	72	0.043	$ 7.11	$ 9.14	$ 430,277.34	$ 553,213.73
Food production (that sustainable portion of GPP)				Yes	$ 295.28	56	72	0.024	$ 3.97	$ 5.10	$ 240,154.80	$ 308,770.45
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 295.28	56	72	0.029	$ 4.80	$ 6.17	$ 290,187.05	$ 373,097.63
Genetic resources (medicines, scientific and technological resources				Yes	$ 295.28	56	72	0.073	$ 12.07	$ 15.52	$ 730,470.84	$ 939,176.79
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 295.28	56	72	0.025	$ 4.13	$ 5.31	$ 250,161.25	$ 321,635.89
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 295.28	56	72	0.054	$ 8.93	$ 11.48	$ 540,348.29	$ 694,733.52
Other non-use values (bequest, option and quasi option values)				Yes	$ 295.28	56	72	0.033	$ 5.46	$ 7.02	$ 330,212.84	$ 424,559.37
								0.999	$ 165.19	$ 212.39	$ 9,996,443.39	$ 12,852,570.07
									56% intact	72% intact		
				TEV ($AUDpa)			**Hectares**	**60,515**	**$ 9,996,443.39**	**$ 12,852,570.07**		
							(Ref WTMA GIS)					

TENURE CATEGORY: ~ LEASEHOLD LAND (PERPETUAL AND EXPIRING, MINES AND ENERGY, DPI, AND EPA) WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		8%				56% intact	66% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 304.80	56	66	0.069	$ 11.78	$ 13.88	$ 1,061,697.56	$ 1,251,286.41
Climate regulation (temperature, rainfall)				Yes	$ 304.80	56	66	0.068	$ 11.61	$ 13.68	$ 1,046,310.64	$ 1,233,151.83
Disturbance regulation (ecosystem resilience)				Yes	$ 304.80	56	66	0.055	$ 9.39	$ 11.06	$ 846,280.67	$ 997,402.21
Water regulation (hydrological cycle)				Yes	$ 304.80	56	66	0.011	$ 1.88	$ 2.21	$ 169,256.13	$ 199,480.44
Erosion control and soil/sediment retention				Yes	$ 304.80	56	66	0.073	$ 12.46	$ 14.69	$ 1,123,245.25	$ 1,323,824.76
Biological control (populations, pest/disease control)				Yes	$ 304.80	56	66	0.063	$ 10.75	$ 12.67	$ 969,376.04	$ 1,142,478.90
Refugia (habitats for resident and transient populations)				Yes	$ 304.80	56	66	0.086	$ 14.68	$ 17.30	$ 1,323,275.22	$ 1,559,574.37
Regeneration Services												
Soil formation				Yes	$ 304.80	56	66	0.010	$ 1.71	$ 2.01	$ 153,869.21	$ 181,345.86
Nutrient cycling and storage				Yes	$ 304.80	56	66	0.039	$ 6.66	$ 7.85	$ 600,089.93	$ 707,248.84
Assimilation of waste and attenuation, detoxification				Yes	$ 304.80	56	66	0.051	$ 8.71	$ 10.26	$ 784,732.98	$ 924,863.87
Purification (clean water, air)				Yes	$ 304.80	56	66	0.058	$ 9.90	$ 11.67	$ 892,441.43	$ 1,051,805.97
Pollination (movement of floral gametes)				Yes	$ 304.80	56	66	0.036	$ 6.14	$ 7.24	$ 553,929.16	$ 652,845.09
Biodiversity				Yes	$ 304.80	56	66	0.099	$ 16.90	$ 19.92	$ 1,523,305.20	$ 1,795,323.99
Production of Goods												
Water supply (catchment)				Yes	$ 304.80	56	66	0.043	$ 7.34	$ 8.65	$ 661,637.61	$ 779,787.19
Food production (that sustainable portion of GPP)				Yes	$ 304.80	56	66	0.024	$ 4.10	$ 4.83	$ 369,286.11	$ 435,230.06
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 304.80	56	66	0.029	$ 4.95	$ 5.83	$ 446,220.72	$ 525,902.99
Genetic resources (medicines, scientific and technological resources				Yes	$ 304.80	56	66	0.073	$ 12.46	$ 14.69	$ 1,123,245.25	$ 1,323,824.76
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 304.80	56	66	0.025	$ 4.27	$ 5.03	$ 384,673.03	$ 453,364.64
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 304.80	56	66	0.054	$ 9.22	$ 10.86	$ 830,893.75	$ 979,267.63
Other non-use values (bequest, option and quasi option values)				Yes	$ 304.80	56	66	0.033	$ 5.63	$ 6.64	$ 507,768.40	$ 598,441.33
								0.999	$ 170.52	$ 200.97	$ 15,371,534.30	$ 18,116,451.14
									56% intact	66% intact		
				TEV ($AUDpa)			**Hectares**	**90,146**	**$ 15,371,534.30**	**$ 18,116,451.14**		
							(Ref WTMA GIS)					

TENURE CATEGORY: ~ FREEHOLD LAND WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		8.25%				48% intact	56% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 314.33	48	56	0.069	$ 10.41	$ 12.15	$ 180,528.46	$ 210,616.53
Climate regulation (temperature, rainfall)				Yes	$ 314.33	48	56	0.068	$ 10.26	$ 11.97	$ 177,912.10	$ 207,564.12
Disturbance regulation (ecosystem resilience)				Yes	$ 314.33	48	56	0.055	$ 8.30	$ 9.68	$ 143,899.49	$ 167,882.74
Water regulation (hydrological cycle)				Yes	$ 314.33	48	56	0.011	$ 1.66	$ 1.94	$ 28,779.90	$ 33,576.55
Erosion control and soil/sediment retention				Yes	$ 314.33	48	56	0.073	$ 11.01	$ 12.85	$ 190,993.87	$ 222,826.19
Biological control (populations, pest/disease control)				Yes	$ 314.33	48	56	0.063	$ 9.51	$ 11.09	$ 164,830.33	$ 192,302.05
Refugia (habitats for resident and transient populations)				Yes	$ 314.33	48	56	0.086	$ 12.98	$ 15.14	$ 225,006.48	$ 262,507.56
Regeneration Services												
Soil formation				Yes	$ 314.33	48	56	0.010	$ 1.51	$ 1.76	$ 26,163.54	$ 30,524.14
Nutrient cycling and storage				Yes	$ 314.33	48	56	0.039	$ 5.88	$ 6.86	$ 102,037.82	$ 119,044.13
Assimilation of waste and attenuation, detoxification				Yes	$ 314.33	48	56	0.051	$ 7.69	$ 8.98	$ 133,434.08	$ 155,673.09
Purification (clean water, air)				Yes	$ 314.33	48	56	0.058	$ 8.75	$ 10.21	$ 151,748.56	$ 177,039.98
Pollination (movement of floral gametes)				Yes	$ 314.33	48	56	0.036	$ 5.43	$ 6.34	$ 94,188.76	$ 109,886.89
Biodiversity				Yes	$ 314.33	48	56	0.099	$ 14.94	$ 17.43	$ 259,019.09	$ 302,188.94
Production of Goods												
Water supply (catchment)				Yes	$ 314.33	48	56	0.043	$ 6.49	$ 7.57	$ 112,503.24	$ 131,253.78
Food production (that sustainable portion of GPP)				Yes	$ 314.33	48	56	0.024	$ 3.62	$ 4.22	$ 62,792.51	$ 73,257.92
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 314.33	48	56	0.029	$ 4.38	$ 5.10	$ 75,874.28	$ 88,519.99
Genetic resources (medicines, scientific and technological resources				Yes	$ 314.33	48	56	0.073	$ 11.01	$ 12.85	$ 190,993.87	$ 222,826.19
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 314.33	48	56	0.025	$ 3.77	$ 4.40	$ 65,408.86	$ 76,310.34
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 314.33	48	56	0.054	$ 8.15	$ 9.51	$ 141,283.14	$ 164,830.33
Other non-use values (bequest, option and quasi option values)				Yes	$ 314.33	48	56	0.033	$ 4.98	$ 5.81	$ 86,339.70	$ 100,729.65
								0.999	$ 150.73	$ 175.85	$ 2,613,738.10	$ 3,049,361.11
									48% intact	56% intact		
				TEV ($AUDpa)			**Hectares**	**17,341**	**$ 2,613,738.10**	**$ 3,049,361.11**		
							(Ref WTMA GIS)					

TENURE CATEGORY: ~ ROADS, ESPLANADES AND RAILWAYS WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		9.0%				39% intact	48% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 342.90	39	48	0.069	$ 9.23	$ 11.36	$ 52,559.77	$ 64,688.95
Climate regulation (temperature, rainfall)				Yes	$ 342.90	39	48	0.068	$ 9.09	$ 11.19	$ 51,798.03	$ 63,751.42
Disturbance regulation (ecosystem resilience)				Yes	$ 342.90	39	48	0.055	$ 7.36	$ 9.05	$ 41,895.47	$ 51,563.65
Water regulation (hydrological cycle)				Yes	$ 342.90	39	48	0.011	$ 1.47	$ 1.81	$ 8,379.09	$ 10,312.73
Erosion control and soil/sediment retention				Yes	$ 342.90	39	48	0.073	$ 9.76	$ 12.02	$ 55,606.71	$ 68,439.03
Biological control (populations, pest/disease control)				Yes	$ 342.90	39	48	0.063	$ 8.43	$ 10.37	$ 47,989.35	$ 59,063.82
Refugia (habitats for resident and transient populations)				Yes	$ 342.90	39	48	0.086	$ 11.50	$ 14.15	$ 65,509.28	$ 80,626.80
Regeneration Services												
Soil formation				Yes	$ 342.90	39	48	0.010	$ 1.34	$ 1.65	$ 7,617.36	$ 9,375.21
Nutrient cycling and storage				Yes	$ 342.90	39	48	0.039	$ 5.22	$ 6.42	$ 29,707.70	$ 36,563.32
Assimilation of waste and attenuation, detoxification				Yes	$ 342.90	39	48	0.051	$ 6.82	$ 8.39	$ 38,848.52	$ 47,813.57
Purification (clean water, air)				Yes	$ 342.90	39	48	0.058	$ 7.76	$ 9.55	$ 44,180.67	$ 54,376.22
Pollination (movement of floral gametes)				Yes	$ 342.90	39	48	0.036	$ 4.81	$ 5.93	$ 27,422.49	$ 33,750.75
Biodiversity				Yes	$ 342.90	39	48	0.099	$ 13.24	$ 16.29	$ 75,411.84	$ 92,814.57
Production of Goods												
Water supply (catchment)				Yes	$ 342.90	39	48	0.043	$ 5.75	$ 7.08	$ 32,754.64	$ 40,313.40
Food production (that sustainable portion of GPP)				Yes	$ 342.90	39	48	0.024	$ 3.21	$ 3.95	$ 18,281.66	$ 22,500.50
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 342.90	39	48	0.029	$ 3.88	$ 4.77	$ 22,090.34	$ 27,188.11
Genetic resources (medicines, scientific and technological resources				Yes	$ 342.90	39	48	0.073	$ 9.76	$ 12.02	$ 55,606.71	$ 68,439.03
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 342.90	39	48	0.025	$ 3.34	$ 4.11	$ 19,043.39	$ 23,438.02
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 342.90	39	48	0.054	$ 7.22	$ 8.89	$ 41,133.73	$ 50,626.13
Other non-use values (bequest, option and quasi option values)				Yes	$ 342.90	39	48	0.033	$ 4.41	$ 5.43	$ 25,137.28	$ 30,938.19
								0.999	$ 133.60	$ 164.43	$ 760,974.04	$ 936,583.43
									39% intact	48% intact		
				TEV ($AUDpa)			**Hectares**	**5,696**	**$ 760,974.04**	**$ 936,583.43**		
							(Ref WTMA GIS)					

TENURE CATEGORY: ~ RIVERS WITHIN THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

The median unimproved value of all rateable land in the eleven Local Govt areas represented in the Wet Tropics Bioregion: $3,810.02 per hectare

Group and Type of Ecosystem Service (Attribute)	Not Present		type of	Present	*UFpa*	% Intact	% Intact	Weighting	Value per ha	Value per ha	TOTAL VALUE	TOTAL VALUE
	temporary	permanent	disturbance		7.50%				48% intact	84% intact	Lower Range	Upper Range
Stabilisation Services												
Gas regulation (atmospheric composition)				Yes	$ 285.75	48	84	0.069	$ 9.46	$ 16.56	$ 31,307.21	$ 54,787.62
Climate regulation (temperature, rainfall)				Yes	$ 285.75	48	84	0.068	$ 9.33	$ 16.32	$ 30,853.48	$ 53,993.59
Disturbance regulation (ecosystem resilience)				Yes	$ 285.75	48	84	0.055	$ 7.54	$ 13.20	$ 24,955.02	$ 43,671.29
Water regulation (hydrological cycle)				Yes	$ 285.75	48	84	0.011	$ 1.51	$ 2.64	$ 4,991.00	$ 8,734.26
Erosion control and soil/sediment retention				Yes	$ 285.75	48	84	0.073	$ 10.01	$ 17.52	$ 33,122.12	$ 57,963.71
Biological control (populations, pest/disease control)				Yes	$ 285.75	48	84	0.063	$ 8.64	$ 15.12	$ 28,584.84	$ 50,023.47
Refugia (habitats for resident and transient populations)				Yes	$ 285.75	48	84	0.086	$ 11.80	$ 20.64	$ 39,020.58	$ 68,286.01
Regeneration Services												
Soil formation				Yes	$ 285.75	48	84	0.010	$ 1.37	$ 2.40	$ 4,537.28	$ 7,940.23
Nutrient cycling and storage				Yes	$ 285.75	48	84	0.039	$ 5.35	$ 9.36	$ 17,695.38	$ 30,966.91
Assimilation of waste and attenuation, detoxification				Yes	$ 285.75	48	84	0.051	$ 7.00	$ 12.24	$ 23,140.11	$ 40,495.19
Purification (clean water, air)				Yes	$ 285.75	48	84	0.058	$ 7.96	$ 13.92	$ 26,316.20	$ 46,053.36
Pollination (movement of floral gametes)				Yes	$ 285.75	48	84	0.036	$ 4.94	$ 8.64	$ 16,334.20	$ 28,584.84
Biodiversity				Yes	$ 285.75	48	84	0.099	$ 13.58	$ 23.76	$ 44,919.04	$ 78,608.32
Production of Goods												
Water supply (catchment)				Yes	$ 285.75	48	84	0.043	$ 5.90	$ 10.32	$ 19,510.29	$ 34,143.01
Food production (that sustainable portion of GPP)				Yes	$ 285.75	48	84	0.024	$ 3.29	$ 5.76	$ 10,889.46	$ 19,056.56
Raw materials (that sustainable portion of GPP, timber, fibre etc.)				Yes	$ 285.75	48	84	0.029	$ 3.98	$ 6.96	$ 13,158.10	$ 23,026.68
Genetic resources (medicines, scientific and technological resources				Yes	$ 285.75	48	84	0.073	$ 10.01	$ 17.52	$ 33,122.12	$ 57,963.71
Life Fulfilling Services												
Recreation opportunities (nature-based tourism)				Yes	$ 285.75	48	84	0.025	$ 3.43	$ 6.00	$ 11,343.19	$ 19,850.59
Aesthetic, cultural and spiritual, (existence values)				Yes	$ 285.75	48	84	0.054	$ 7.41	$ 12.96	$ 24,501.29	$ 42,877.26
Other non-use values (bequest, option and quasi option values)				Yes	$ 285.75	48	84	0.033	$ 4.53	$ 7.92	$ 14,973.01	$ 26,202.77
								0.999	$ 137.02	$ 239.79	$ 453,273.93	$ 793,229.38
									48% intact	84% intact		
				TEV ($AUDpa)			**Hectares**	**3,308**	**$ 453,273.93**	**$ 793,229.38**		
							(Ref WTMA GIS)					