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Wildlife Research

Supplementary Material

Remote sensing shows south-east Queensland koalas (*Phascolarctos cinereus*) prefer areas of higher tree canopy height within their home ranges

Dave L. Mitchell[A,B,*], *Mariela Soto-Berelov*[B], *and Simon D. Jones*[B]

[A]Australian Koala Foundation, GPO Box 2659, Brisbane, Qld 4001, Australia.

[B]School of Science, RMIT University, Melbourne, Vic. 3000, Australia.

[*]Correspondence to: Dave L. Mitchell 46 Simson Street, Carisbrook, Vic. 3464, Australia Email: dave.mitchell@skymesh.com.au

Supplementary Material: Detailed results

For reference, we reproduce Figure 7 from the main text (Figure A1), and the associated significance table (Table A1). We then show results for all height classes, firstly in patches grouped by Land zone, and then individual RE patches, but, because the primary aim is to quantify differences between core and non-core home range components for Class 1 (highest canopy class), we only show these.

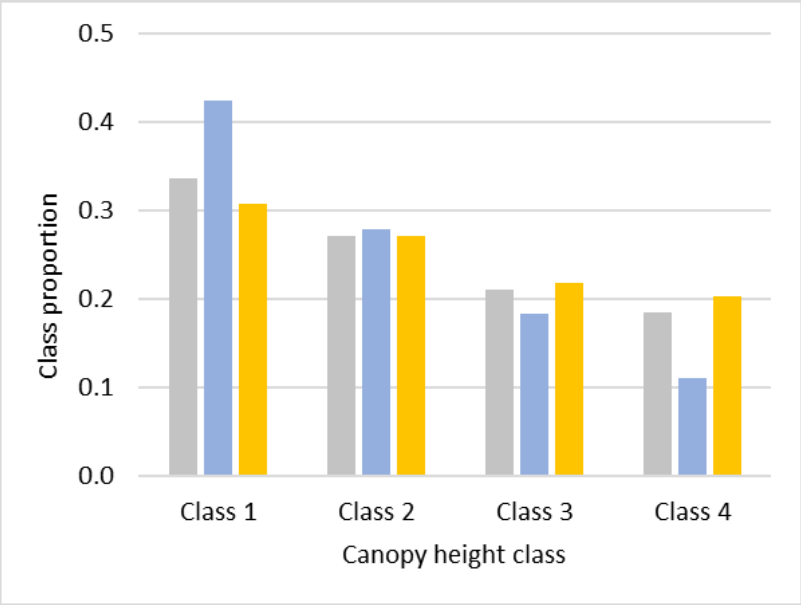

Figure A1: Distribution of canopy height classes within 225 entire home range patches (grey); and within core (50% kernel density estimate, blue) and non-core (remainder of 95% kernel density estimate, orange) components of the same patches. The mean proportion of Class 1 within entire patches is 0.34, but, in the core patch component, Class 1 occupies a higher proportion of the patch area (0.42) compared to the non-core component (0.31). Classes 2 and 3 are fairly evenly distributed, and for Class 4 (lowest canopy height) the proportion is higher in non-core areas (0.20) than core areas (0.11).

Table A1: For the combined dataset, canopy height Class 1 (highest canopy) is a significantly higher component of core areas compared to non-core areas (*t*-test for paired means). There is no significant difference in core and non-core areas for Class 2. Class 3 had significant differences, and, for Class 4 (which also includes cleared areas and scattered trees in some home ranges) the differences were highly significant. Sig. = significance *p*-value for difference between core and non-core proportions, df = degrees of freedom. To assess further core/non-core comparisons with lower df, for comparison we used Cohen's *d* as shown here, values > 0.3 indicate a moderate effect.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.423	0.359	0.307	0.270	0.116	2.4E-11	224	0.37
2	0.278	0.307	0.271	0.219	0.007	0.315	224	0.03
3	0.183	0.260	0.218	0.211	-0.035	0.008	224	0.15
4	0.110	0.201	0.203	0.221	-0.093	9.4E-14	224	0.44

Land zones

Here we describe height class distribution across the four Land zones encompassed by our study, with slightly more detail than Fig. 8. As noted above, we only show core and non-core patch components.

Land zone 3

Fig. A2 shows height class distribution for the 106 patches in Land zone 3 (alluvial river and creek flats). Class 1 occupies a greater proportion of the core area (39.1%) compared to non-core areas (29.0%), Class 2 is evenly distributed, Classes 3 and 4 occupy a greater proportion of non-core areas. Distribution of Classes 1, 3 and 4 are significantly different between core and non-core areas, but not Class 2 (Table A2).

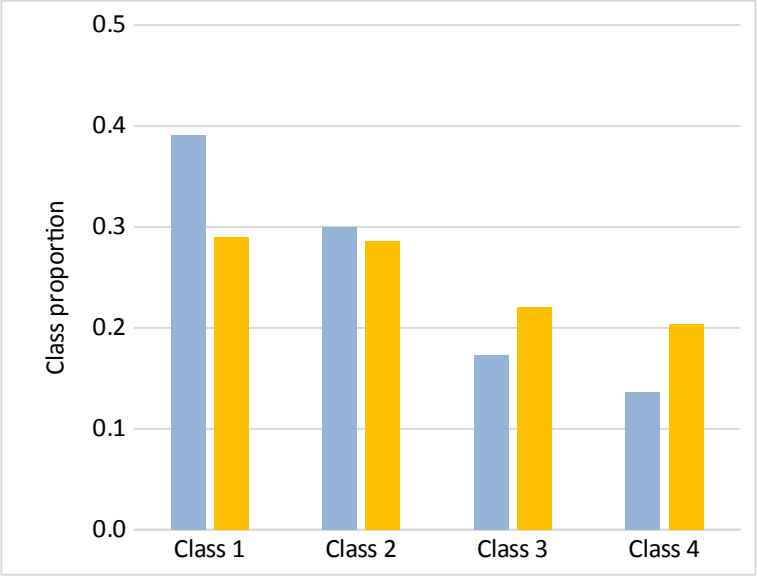

Figure A2: Height class distribution in Land zone 3 shows the same trends as Fig. A1, i.e., core areas have a higher proportion of Class 1 than non-core areas, and Class 4 occupies a higher proportion of non-core areas. Class 3 occupies a slightly higher proportion of non-core areas.

Table A2: Height class distribution between core and non-core areas in Land zone 3. Classes 1, 3 and 4 are significantly different, Class 2 is not. With df = 105, this analysis has slightly less statistical power (measured by Cohen's *d*) to the overall analysis (df= 224) shown in Table A1.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.391	0.352	0.290	0.275	0.101	2.615E-05	105	0.320
2	0.300	0.308	0.286	0.226	0.014	0.259	105	0.051
3	0.173	0.253	0.220	0.207	-0.047	0.005	105	0.204
4	0.136	0.228	0.204	0.214	-0.067	2.806E-05	105	0.305

Land zone 5

Fig. A3 shows height class distribution for the 55 patches in Land zone 5 (old loamy and sandy plains). Class 1 occupies a greater proportion of the core area (41.1%) compared to non-core areas (28.1%), Class 2 is evenly distributed, Classes 3 and 4 occupy a greater proportion of non-core areas. Distribution of Class 1 is significantly different between core (41.1%) and non-core areas (28.1%) and Class 4 (10.3% and 22.4%), but not Classes 2 and 3 (Table A3).

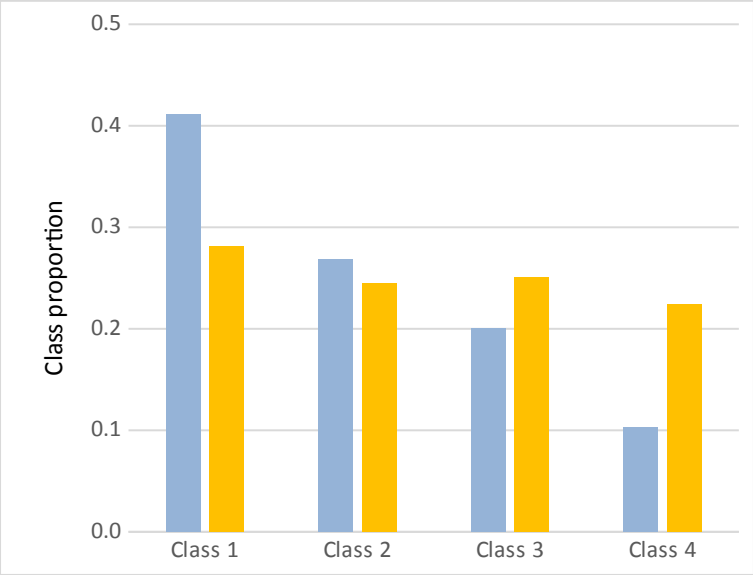

Figure A3: Height class distribution in Land zone 5 shows the same trends as Fig. A1, i.e., core areas have a higher proportion of Class 1 than non-core areas, Classes 2 and 3 are similar, and Class 4 occupies a much smaller proportion of core areas compared to non-core areas.

Table A3: Height class distribution between core and non-core areas in Land zone 5. Again, Classes 1 and 4 are significantly different, Class 2 is not, and Class 3 approaches significance. Because the mean differences between core and non-core areas are larger than those shown in Table A1, this analysis has slightly greater statistical power (measured by Cohen's *d*) for Classes 1 and 4, even with smaller df.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.411	0.358	0.281	0.243	0.130	1.1E-04	54	0.424
2	0.268	0.286	0.244	0.193	0.024	0.235	54	0.097
3	0.200	0.282	0.251	0.246	-0.051	0.060	54	0.191
4	0.103	0.203	0.224	0.227	-0.121	5.4E-06	54	0.562

Land zone 11

Fig. A4 shows height class distribution for the 54 patches in Land zone 11 (hills and lowlands on metamorphic rocks). Class 1 occupies a higher proportion of both core (50.2%) and non-core (36.6%) areas compared to Land zones 3 and 5. Classes 2 and 3 are evenly distributed, Class 4 again occupies a greater proportion of non-core areas (17.5%) compared to core areas (7.2%). Distribution of Classes 1 and 4 are significantly different between core and non-core areas, but not Classes 2 and 3 (Table A4).

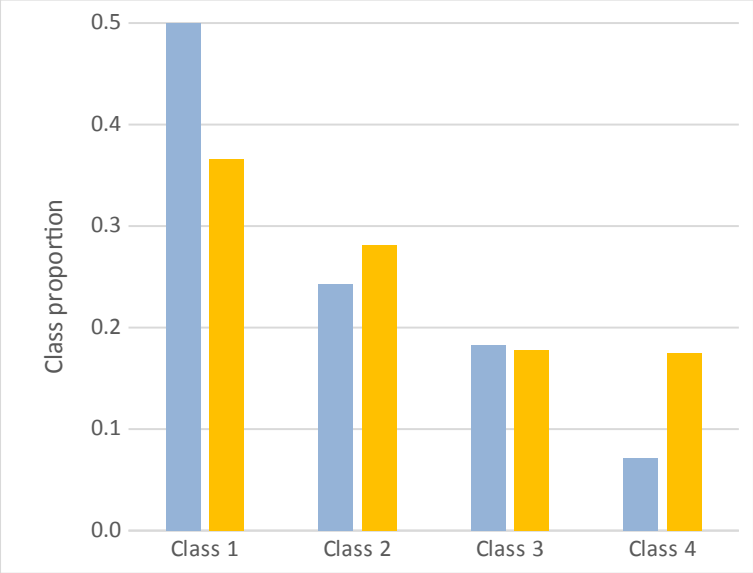

Figure A4: Height class distribution in Land zone 11 shows the same trends as Fig. A1, i.e., core areas have a higher proportion of Class 1 than non-core areas. However, the proportion of Class 1 is higher in both core and non-core areas than Fig. A1, and higher than Land Zones 3 and 5. Classes 2 and 3 are distributed evenly, and Class 4 is poorly represented in core areas.

Table A4: Height class distribution between core and non-core areas in Land zone 11. Classes 1 and 4 are significantly different. Because the mean differences between core and non-core areas are larger than those shown in Table A1, this analysis has similar statistical power (measured by Cohen's *d*), even with smaller df.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.502	0.365	0.366	0.292	0.136	1.68E-04	53	0.411
2	0.243	0.327	0.281	0.246	-0.038	0.105	53	0.131
3	0.183	0.245	0.177	0.181	0.006	0.426	53	0.026
4	0.072	0.142	0.175	0.231	-0.103	4.27E-05	53	0.540

Land zones 10 and 4

This combination of Land zones (fine and coarse-grained sedimentary rocks) only occurs in RE 12.9-10.4, with 10 patches. It was shown in the main results, we here reproduce it in the same form (Fig. A5) as other Figures in this Appendix. Class 1 again has a higher proportion in core areas (41.4%) compared to non-core areas (32.1%), but differences are not statistically significant; for Class 4, differences between core (8.5%) and non-core (23.8%) are statistically significant (Table A5).

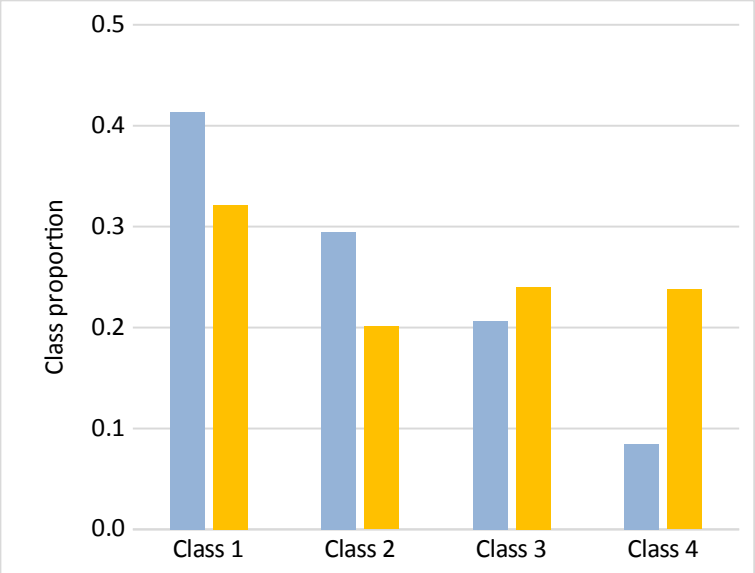

Figure A5: Height class distribution in Land zones 10 and 4 (RE 10.9-10.4) shows the same trends as Fig. A1, i.e., core areas have a higher proportion of Class 1 than non-core areas. Class 2 also has a higher proportion in core areas, Class 3 is evenly distributed, and Class 4 is poorly represented in core areas.

Table A5: Height class distribution between core and non-core areas in Land zones 10 and 4 (RE 10.9-10.4). Only Class 4 distribution is significantly different. Mean differences between core and non-core areas are smaller than those shown in the preceding Tables, and, allied with smaller df, this analysis does not have the required statistical power (measured by Cohen's *d*) to differentiate Classes 1 -3.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.414	0.398	0.321	0.211	0.093	0.194	9	0.290
2	0.295	0.311	0.201	0.101	0.093	0.136	9	0.403
3	0.207	0.312	0.240	0.184	-0.033	0.395	9	0.129
4	0.085	0.121	0.238	0.232	-0.153	0.039	9	0.826

Individual Regional Ecosystems

Here, we continue the analysis for individual REs, ordered by decreasing number of patches.

RE 12.5.3 (41 patches)

The proportion of Class 1 in core areas (41.8%) was greater than in non-core areas (29.4%), Classes 2 and 3 were not significantly different, and Class 4 departed from previous trends, with a higher proportion in core areas (21.2%) compared to non-core areas (8.1%) (Fig. A6, Table A6).

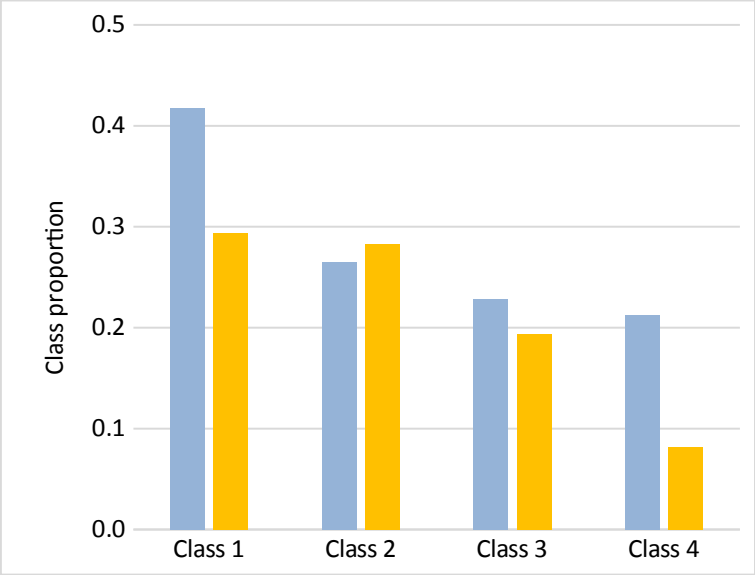

Figure A6: Height class distribution for RE 12.5.3. Core areas have a higher proportion of Class 1 compared to non-core areas. Classes 2 and 3 are evenly distributed. In contrast to the preceding graphs, core areas have a much higher proportion of Class 4 compared to non-core areas.

Table A6: Height class distribution between core and non-core areas in RE 12.5.3. Core area Class 1 proportions are higher than in preceding graphs, and significantly different to non-core areas. Classes 2 and 3 are not significantly different, and the proportion of Class 4 is significantly higher in core areas.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.418	0.364	0.294	0.243	0.124	1.46E-03	40	0.401
2	0.283	0.299	0.265	0.196	0.017	0.313	40	0.065
3	0.194	0.272	0.229	0.216	-0.035	0.121	40	0.142
4	0.081	0.171	0.212	0.207	-0.131	1.75E-07	40	0.688

RE 12.3.11/12.3.6/12.3.5 (31 patches)

This RE mosaic shows clear differences in height class distribution across home ranges, Class 1 makes up almost 50% of core areas, and 38% of non-core areas, Classes 2 and 3 are evenly distributed, and only one core area patch contained Class 4. Differences were significant for Classes 1 and 4 (Fig. A7, Table A7).

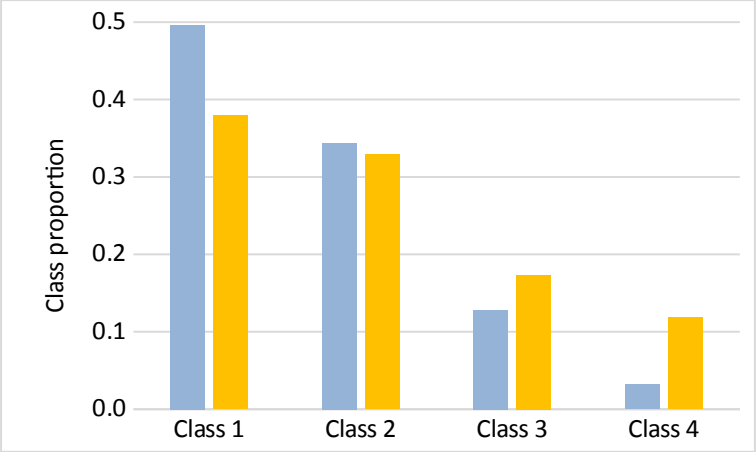

Figure A7: Height class distribution for 12.3.11/12.3.6/12.3.5. Again, the proportion of Class 1 is higher in the core home range compared to non-core areas, Class 2 is evenly distributed between core and non-core areas, and Class 4 occurred in the core area of only one home range patch.

Table A7: For RE 12.3.11/12.3.6/12.3.5, there were significant differences in the distribution of Classes 1 and 4, but not Class 2, and Class 3 approaches significance.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.496	0.348	0.379	0.283	0.117	1.6E-04	30	0.368
2	0.344	0.294	0.329	0.218	0.015	0.323	30	0.058
3	0.128	0.234	0.173	0.191	-0.045	0.064	30	0.210
4	0.032	0.067	0.119	0.119	-0.087	9.4E-07	30	0.904

RE 12.11.18/12.11.25 (25 patches)

This mosaic RE also showed strong trends, Class 1 occupied 52.3% of core areas, and 42.9% of non-core areas. There was a slightly greater proportion of Class 2 in non-core areas, Class 3 was evenly distributed, and non-core areas contained a greater proportion of Class 4. Again, differences were only significant for Classes 1 and 4 (Fig. A8, Table A8).

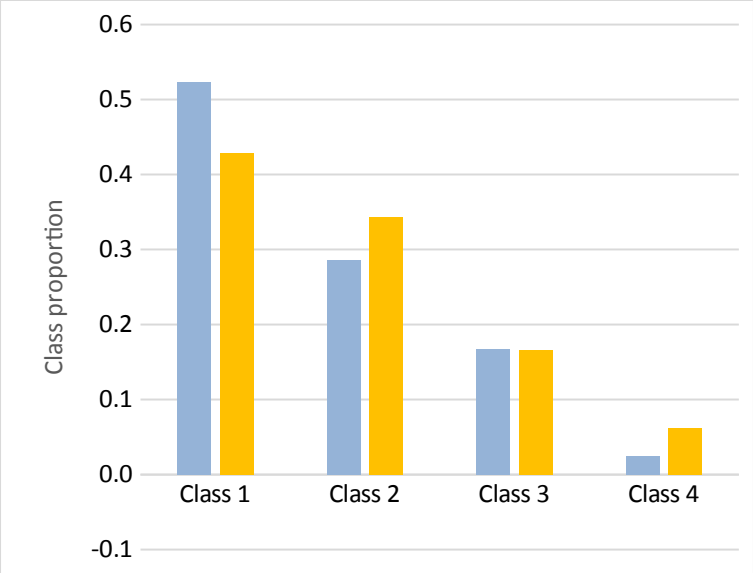

Figure A8: Height class distribution for RE 12.11.18/12.11.25. Class 1 occupies 52.3% of core areas compared to 42.9% of non-core areas. Class 2 occupies a slightly greater proportion in non-core areas, Class 3 is evenly distributed, and Class 4 is poorly represented in both core and non-core areas.

Table A8: For RE 12.11.18/12.11.25 there were, again, significant differences between Classes 1 and 4 but not for other classes.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's d
1	0.523	0.357	0.429	0.248	0.094	0.009	24	0.307
2	0.285	0.320	0.343	0.265	-0.058	0.090	24	0.196
3	0.167	0.225	0.166	0.176	0.001	0.487	24	0.005
4	0.025	0.038	0.062	0.063	-0.038	0.002	24	0.723

RE 12.3.5 (18 patches)

Compared to all other analyses, for this RE there were no apparent, or significant, differences between core and non-core areas in the distribution of any height class (Fig. A9, Table A9). We expect that df = 17 would be sufficient to show any significant differences.

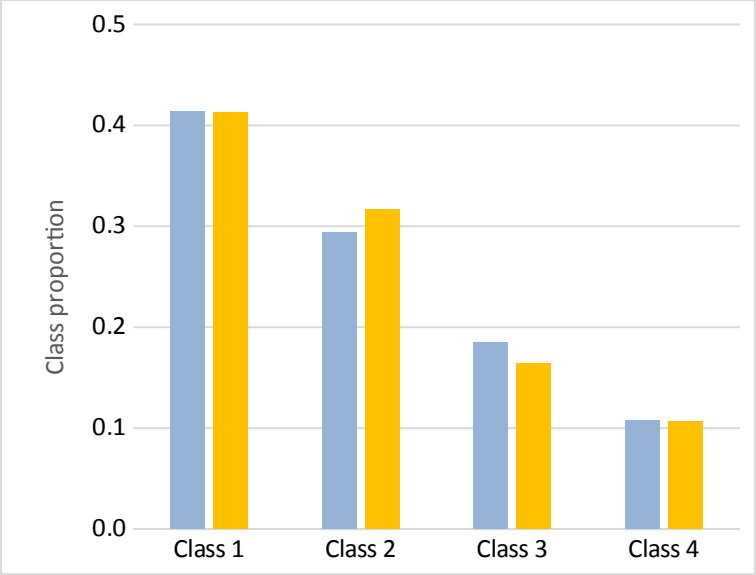

Figure A9: Height class distribution for RE 12.3.5. In contrast to all our other analyses, there appears to be no difference between core and non-core areas in the distribution of any height class.

Table A9: For RE 12.3.5, class area proportions were very similar between core and non-core areas, with no significant differences between any height classes. Similarly, Cohen's *d* shows no effect.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.414	0.357	0.412	0.291	0.002	0.491	17	0.005
2	0.294	0.287	0.317	0.214	-0.023	0.360	17	0.092
3	0.185	0.213	0.164	0.133	0.020	0.336	17	0.115
4	0.107	0.145	0.106	0.115	0.001	0.486	17	0.010

RE 12.11.18a (14 patches)

With 62.4% of core areas comprised of Class 1, and 52.5% of non-core areas, this RE has the highest proportion of Class 1 in any RE. Class 2 is evenly distributed, and Classes 3 and 4 were poorly represented in core areas. There were no significant differences between core and non-core areas for Classes 1 – 3, however Cohen's d shows some effect for Class 1 (Fig. A10, Table A10).

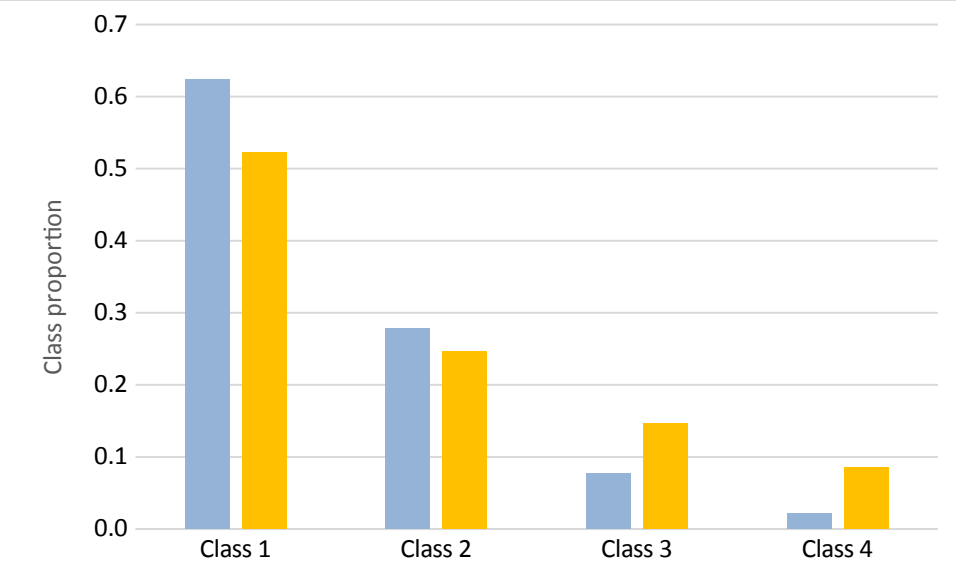

Figure A10: Height class distribution for RE 12.11.18a. The proportion of Class 1 is higher in the core home range, Class 2 is evenly distributed, with smaller core area proportions for other classes.

Table A10: For RE 12.11.18a there were significant differences between core and non-core areas only for Class 4, however for Class 1, Cohen's *d* (0.27) indicates a small-medium effect.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.624	0.395	0.522	0.343	0.102	0.146	13	0.274
2	0.278	0.390	0.247	0.252	0.031	0.343	13	0.094
3	0.077	0.130	0.146	0.166	-0.069	0.097	13	0.464
4	0.021	0.059	0.085	0.118	-0.063	0.019	13	0.681

RE 12.3.11/12.3.6/12.3.16 (11 patches)

In this RE mosaic Class 1 occupies 40.8% or core areas compared to 27.2% of non-core areas, Classes 2 and 3 are evenly distributed, and Class 4 occupies a greater proportion of non-core areas compared to core areas. Differences in Class 1 distribution are significant at $p = 0.05$, but not for other classes (Fig. A11, Table A11).

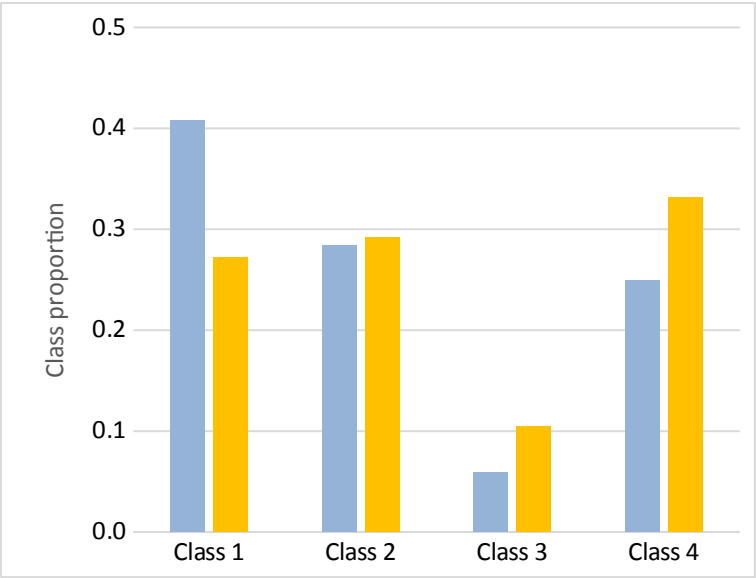

Figure A11: Height class distribution for RE 12.3.11/12.3.6/12.3.16. Class 1 occupies a greater proportion of core areas than non-core areas. Compared to other REs, this RE has a high proportion of Class 4 in both core and non-core areas.

Table A11: For RE 12.3.11/12.3.6/12.3.16, there was a significant difference in the distribution of Class 1 at $p = 0.05$ but not for other classes. For Classes 3 and 4, Cohen's *d* indicates a moderate effect.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
Class 1	0.408	0.322	0.272	0.204	0.135	0.051	110	0.502
Class 2	0.284	0.313	0.291	0.192	-0.007	0.460	110	0.028
Class 3	0.059	0.132	0.104	0.069	-0.045	0.101	110	0.428
Class 4	0.249	0.262	0.332	0.234	-0.083	0.106	110	0.334

RE 12.3.6/12.3.5/12.3.11/12.3.16 (10 patches)

In this mosaic RE, Class 1 comprised 30.0% of core areas, and 10.9% of non-core areas, i.e., the lowest proportion of Class 1 in any RE, and Class 2 comprised a higher proportion of both core (39.4%) and non-core (26.5%) compared to Class 1. Other classes followed previous trends, i.e., with higher representation in non-core areas. Differences were significant for all classes except Class 2; however, Cohen's *d* indicates a moderate effect (Fig. A12, Table A12).

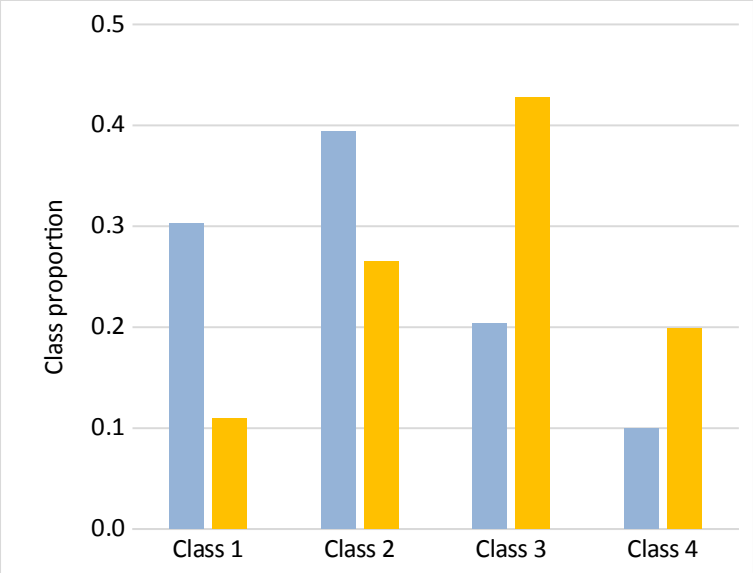

Figure A12: Height class distribution RE 12.3.6/12.3.5/12.3.11/12.3.16. Classes 1 and 2 proportions are much higher in core areas than non-core areas compared to other classes.

Table A12: RE 12.3.6/12.3.5/12.3.11/12.3.16 shows significant differences for Classes 1, 3, and 4 between core and non-core areas. Class 2 is not significantly different, but Cohen's *d* indicates a moderate effect.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.303	0.342	0.109	0.123	0.193	0.036	9	0.755
2	0.394	0.374	0.265	0.240	0.129	0.082	9	0.411
3	0.204	0.199	0.427	0.232	-0.224	0.001	9	1.032
4	0.100	0.112	0.199	0.217	-0.099	0.036	9	0.573

RE 12.11.5 (9 patches)

This RE showed strong trends, with core areas occupied by 42.9% of Class 1, compared to 9.7% in non-core areas. Classes 2 and 3 were more evenly distributed, and Class 4 occupied 50.4% of non-core areas compared to 12.6% of core areas. Differences were significant for Classes 1 and 4, and large mean differences between core and non-core areas for these classes provides ample statistical power as indicated by Cohen's *d* (Fig. A13, Table A13).

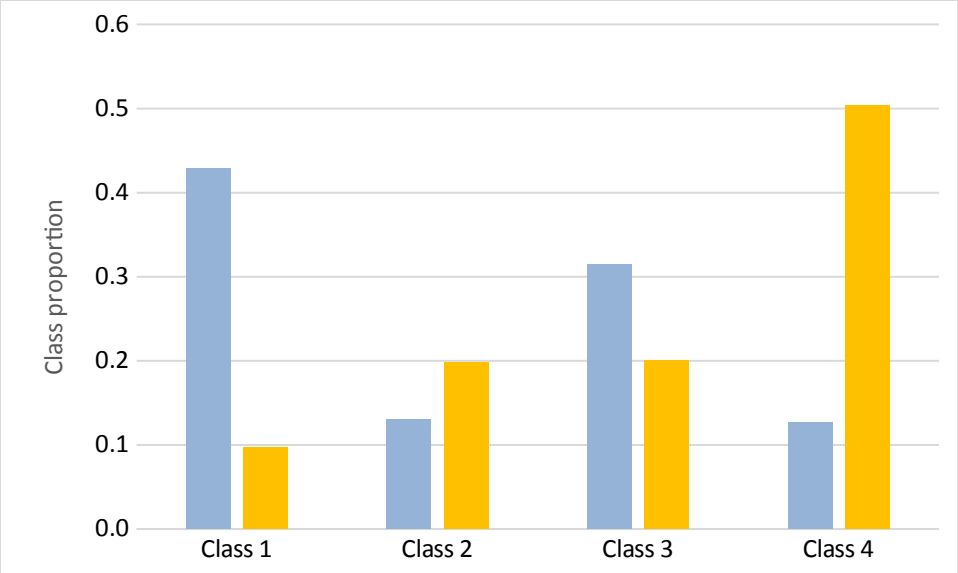

Figure A13: Height class distribution for RE 12.11.5. Class 1 occupies a much greater proportion of core areas compared to non-core areas, and Class 4 occupies 50.4% of non-core areas compared to 12.6% of core areas. Classes 2 and 3 are more evenly distributed.

Table A13: For RE 12.11.5 there were significant differences between Classes 1 and 4. Because there are large mean differences within these classes, and very high values in Cohen's *d*, we have confidence in the differences being significant even with df = 8.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.429	0.369	0.097	0.083	0.331	0.005	8	1.241
2	0.131	0.324	0.198	0.215	-0.067	0.085	8	0.244
3	0.314	0.345	0.201	0.197	0.114	0.150	8	0.402
4	0.126	0.170	0.504	0.292	-0.378	0.001	8	1.582

RE 12.3.6/12.3.5 (9 patches)

In this RE, Class 1 formed only a small proportion of core (19.8%) and non-core (7.6%) areas, with a clear majority of patches occupied by Class 2 and 3. There were significant differences between core and non-core areas only for Class 4, and Cohen's *d* was similar for both Classes 1 and 4 (i.e., moderate-high effect size) (Fig. A14, Table A14).

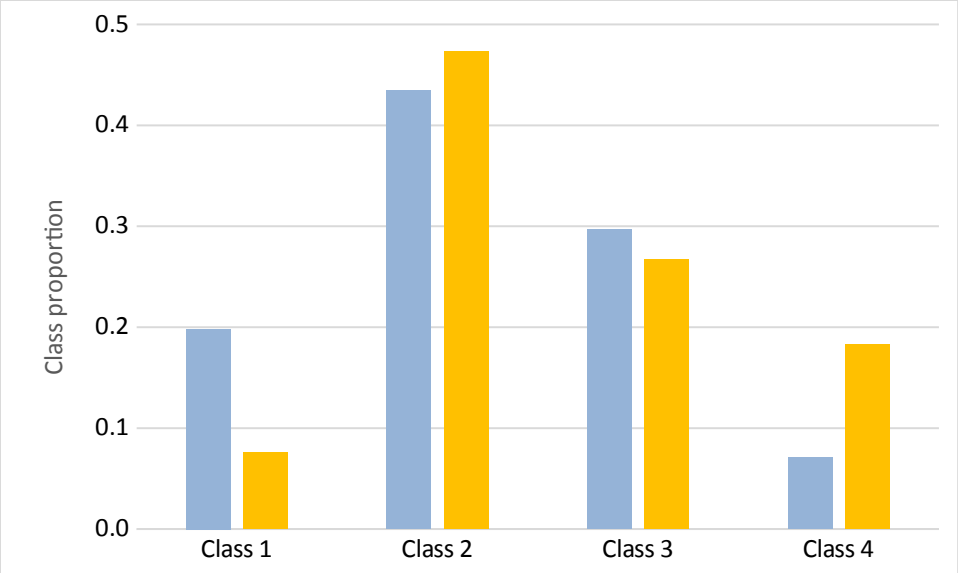

Figure A14: Height class distribution for RE 12.3.6/12.3.5, with 9 patches. Classes 2 and 3 form the largest component of core and non-core areas, Class 1 occupies 19.8% of core areas and only 7.6% of non-core areas. Class 4 has a greater proportion of non-core areas compared to core areas.

Table A15: For RE 12.3.6/12.3.5 there were only significant differences between core and non-core areas for Class 4, Class 1 mean differences were not significantly different ($p = 0.125$) but Cohen's d suggest there is some merit in recognising core and non-core differences for this class.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.198	0.305	0.076	0.066	0.122	0.125	8	0.553
2	0.434	0.441	0.473	0.321	-0.039	0.335	8	0.101
3	0.297	0.410	0.268	0.262	0.029	0.379	8	0.084
4	0.071	0.188	0.183	0.223	-0.112	0.043	8	0.543

RE 12.3.11 (8 patches)

Class 1 occupied a smaller overall proportion of patch area; proportions were higher in core (30.3%) than non-core (20.2%) areas but not significantly different ($p = 0.07$). For other classes, there were no significant differences is distribution between core and non-core areas. Classes 3 and 4 form a higher proportion of patches compared to other REs (Fig. A15, Table A15).

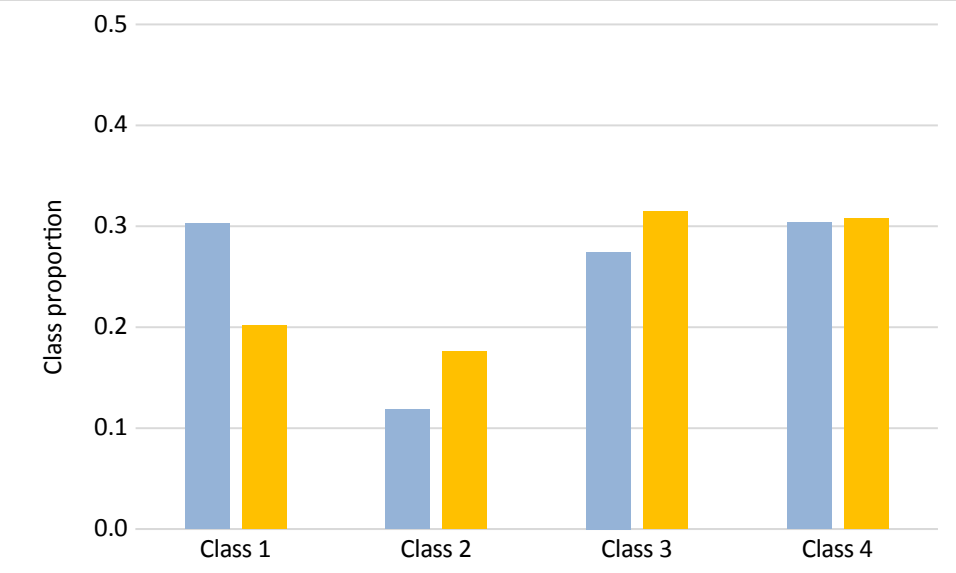

Figure A15: Height class distribution for RE 12.3.11. Class 1 occupies a smaller proportion of home range patches compared to other REs, but Class 1 is still more prominent in core areas, and Classes 3 and 4 comprise a higher proportion of patches compared to other REs.

Table A15: Class 1 comprised a smaller overall proportion of patches in RE 12.3.11 compared to other REs, but still comprised a greater proportion of core areas than non-core areas, this difference was not significant at $p = 0.05$ but Cohen's d (0.298) confirms some difference.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.303	0.409	0.202	0.248	0.101	0.073	7	0.298
2	0.119	0.162	0.176	0.182	-0.057	0.102	7	0.330
3	0.275	0.373	0.315	0.276	-0.040	0.283	7	0.122
4	0.304	0.373	0.308	0.222	-0.004	0.479	7	0.013

RE 12.3.6 (8 patches)

Class 1 occupies a greater proportion of core (35.1%) than non-core (20.0%) areas, but the difference is not significant at $p = 0.05$. Class 2 is evenly distributed, and Classes 3 and 4 have a higher proportion in non-core areas (Fig A16, Table A16).

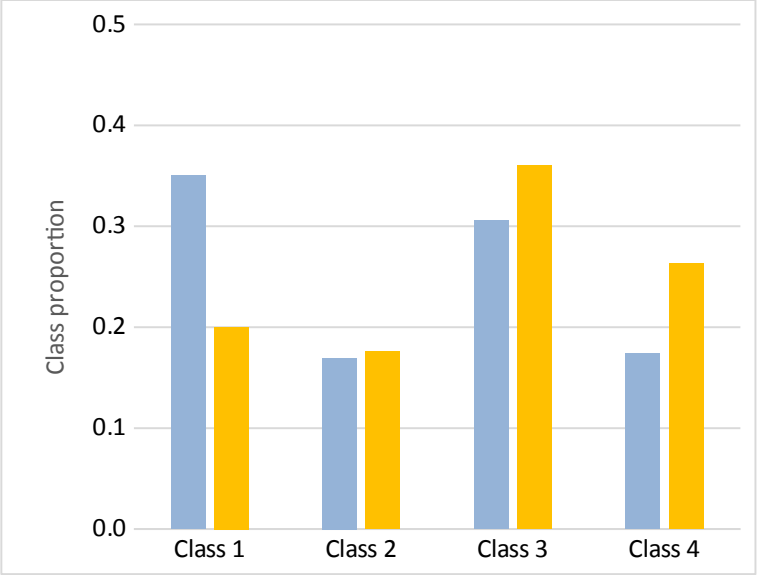

Figure A16: Height class distribution for RE 12.3.6 (8 patches). The proportion of Class 1 is higher in core areas, Classes 2 and 3 are evenly distributed, and Class 4 occupies a greater proportion of non-core areas.

Table A16: For RE 12.3.6 there were no significant differences at p = 0.05, but Cohen's *d* (0.439) shows a moderate difference in the distribution of Class 1 canopy height between core and non-core areas.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's *d*
1	0.351	0.393	0.200	0.286	0.150	0.059	7	0.439
2	0.169	0.201	0.176	0.148	-0.007	0.446	7	0.040
3	0.306	0.307	0.360	0.225	-0.055	0.222	7	0.201
4	0.174	0.348	0.263	0.227	-0.089	0.169	7	0.303

RE 12.5.2a (7 patches)

As a proportion of area, this RE has almost twice as much Class 1 in core areas (44.6%) compared to non-core areas (24.3%), Class 2 is evenly distributed, Class 3 is prominent in non-core areas, and Class 4 is evenly distributed. Differences are significant for Classes 1 and 3, with strong support from Cohen's *d* (Fig. A17, Table A17).

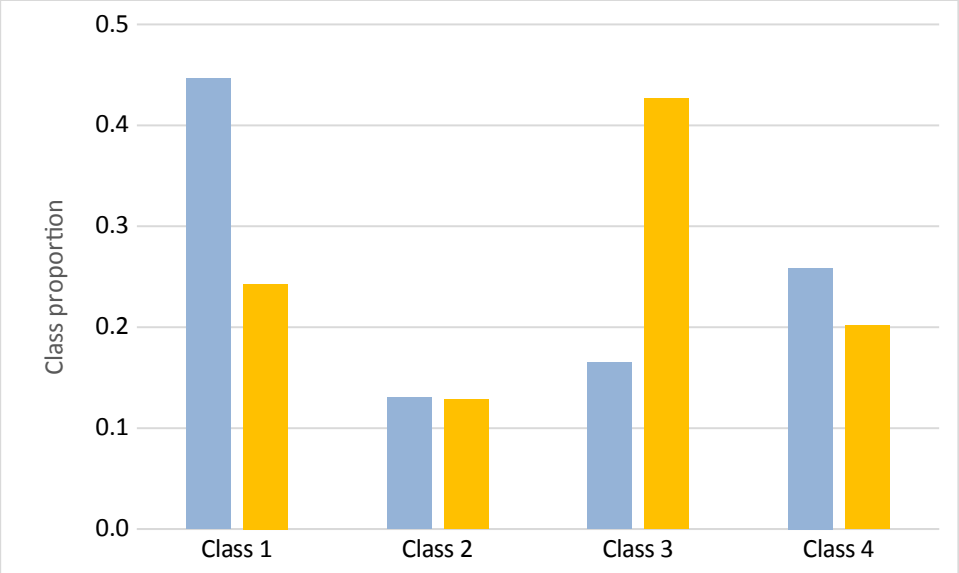

Figure A17: Height class distribution for RE 12.5.2a (7 patches). The proportion of Class 1 is higher in core areas, Class 2 is evenly distributed, and Class 3 occupies a greater proportion of non-core areas.

Table A17: For RE 12.5.2a, Class 1 distribution was significantly different in core and non-core areas (p = .015), and Class 3.

Height class	core class mean	standard deviation	non-core class mean	standard deviation	mean difference	Sig.	df	Cohen's d
1	0.446	0.270	0.243	0.215	0.204	0.015	6	0.832
2	0.130	0.119	0.128	0.136	0.002	0.490	6	0.016
3	0.165	0.228	0.427	0.328	-0.262	0.024	6	0.928
4	0.259	0.340	0.202	0.259	0.057	0.313	6	0.189

Other REs

For the seven REs with less than seven patches, we present these in graphical form for Class 1 only, with no statistical analysis. Class 1 proportions are higher in core areas for five REs (Fig. A18). Of some interest is RE 12.1.1/12.3.6, where 62% of the core is comprised of Class 1. The entire patch can be described as "*Casuarina glauca* (RE 12.1.1) with *Eucalyptus tereticornis* (RE 12.3.6) emergents" (DES 2021c), we assume the core area in this patch is predominantly composed of *Eucalyptus tereticornis*.

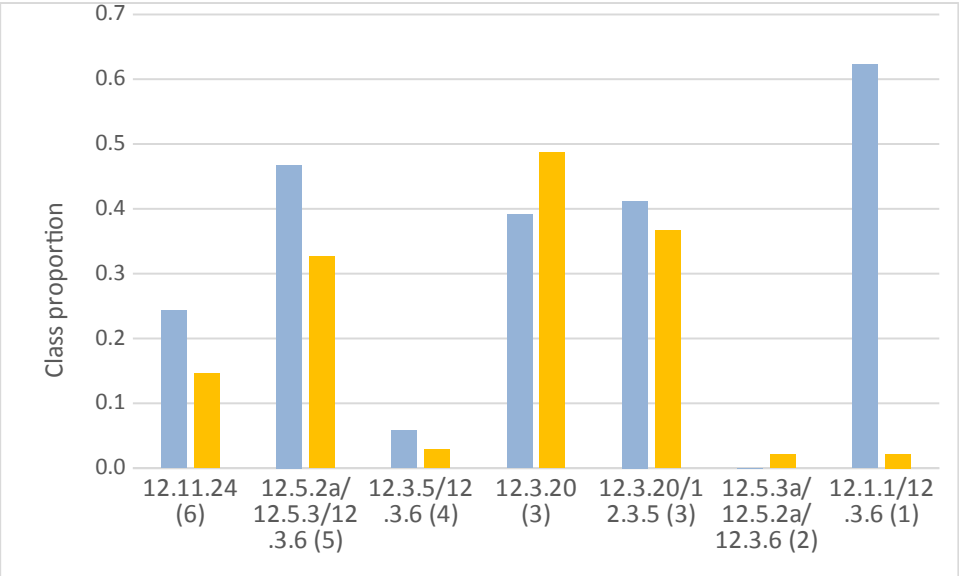

Figure A17: Height class distribution for REs with less than 7 patches. The proportion of Class 1 is higher in core areas for 5 of the 7 REs.