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Title: **Strictly protected areas are not necessarily more effective than areas in which multiple human uses are allowed**

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Table S1. List of studies included in the literature review

Year	Study region	Index used	IUCN Categories	Conclusions	Reference
2008	Global (Amazon forest, South American Atlantic coast forest, Congo forest, West African forest)	Natural vegetation	Strict: I-IV Non-strict: V-VI	Levels of natural vegetation were similar in both types of PAs (except in the West African forest in which natural vegetation was higher in categories I-IV compared to V and VI).	[1]
2010	Global	Human footprint index (used as a proxy of naturalness)	Each IUCN category was analyzed separately	The levels of human footprint within each category did not correspond to the expected gradient of naturalness (in a globally consistent manner).	[2]
2010	Global (tropical forests)	Deforestation and loss in carbon stock	Strict: I-II Non-strict: III-VI and PAs with no category	Strict PAs had lower rates of deforestation and carbon loss.	[3]
2010	Global	Anthropogenic disturbance (measured using changes in land-cover)	Strict: I-II Non-strict: III-VI	Strict PAs were more successful in reducing anthropogenic disturbance (although size was also important).	[4]
2011	Global	Normalized Difference Vegetation Index (NDVI)	Strict: I-III Non-strict: IV-V (Category VI was excluded)	Strict PAs were in more “natural state” (and were becoming increasingly isolated).	[5]
2011	Global (tropical forests)	Forest fires (used as a proxy of deforestation rates)	Strict: I-IV Non-strict: V-VI	Non-strict PAs had lower rates of forest fires compared to strict PAs (except in Africa in which there were insufficient data to compare the two types of protected areas).	[6]

Year	Study region	Index used	IUCN Categories	Conclusions	Reference
2012	Global (tropical forests)	Deforestation	Strict: I-IV Non-strict: V-VI and PAs with no category	Non-strict PAs had lower (and less variable) deforestation rates compared to strict PAs.	[7]
2012	Costa Rica	Forest regrowth	Strict: I, II, and IV Non-strict: VI	Levels of forest regrowth did not vary substantially between the two types of protected areas.	[8]
2012	Canada	Developed land (i.e., roads, urban areas, and croplands)	Strict: I-IV Non-strict: V-VI	Non-strict PAs had more roads and croplands. However, there was no significant difference in urban areas.	[9]
2013	Global (Bolivia, Costa Rica, Indonesia, Thailand)	Deforestation	Strict: I-IV Non-strict: V-VI	Deforestation rates were lower within strict PAs compared to non-strict PAs.	[10]
2013	Spain	Management practices and regulations	Each IUCN category was analyzed separately	IUCN categories correlated only weakly with management practices and regulations of PAs.	[11]
2013	Latin America	Land and forest degradation	Strict: I-IV Non-strict: V-VI	There was no significant difference between the two categories.	[12]
2014	Cerrado Biodiversity Hotspot (Brazil)	Deforestation	Strict: I-IV Non-strict: V-VI	Strict PAs were more effective at reducing habitat conversion compared to non-strict PAs.	[13]
2014	Brazilian Amazon	Deforestation	Strict: I-IV Non-strict: V-VI	Non-strict PAs were more likely to be found in areas with higher deforestation rates and hence more likely to undergo deforestation.	[14]
2014	Global	Species richness and abundance of	Each IUCN category was analyzed separately	There was no clear relationship between the effectiveness of the protected areas and their	[15]

Year	Study region	Index used	IUCN Categories	Conclusions	Reference
		vertebrates, invertebrates, and plants.		IUCN category. However, protected areas had higher biodiversity than areas outside.	
2015	Cerrado Biodiversity Hotspot (Brazil)	Deforestation	Strict: I-III Non-strict: IV-VI	Strict PAs were more effective at reducing deforestation rates compared to non-strict PAs	[16]
2015	Mexico	Deforestation	Strict: I-IV Non-strict: V-VI	Non-strict PAs were more effective than strict PAs at reducing deforestation rates (due to the forest concessions).	[17]
2015	Guatemala	Deforestation	Strict: I-IV Non-strict: V-VI	Non-strict PAs were more effective than strict PAs at reducing deforestation rates (due to the forest concessions).	[18]
2015	Indonesia	Deforestation	Each IUCN category was analyzed separately	Strict PAs were not necessarily more effective in reducing deforestation. Overall, deforestation was higher within Categories Ia and V.	[19]
2015	European Russia	Deforestation	Strict: Zapovedniks (I) Non-strict: National Parks (II or IV) & Federal Zakazniks (IV or V)	No substantial differences in the effectiveness of the two types of PAs.	[20]
2016	Carpathian Mountains in Eastern Europe	Deforestation	Strict: I-II Non-strict: III-VI	Strict PAs were not necessarily more effective than non-strict PAs.	[21]
2016	Peru (Peruvian Amazon)	Deforestation and human disturbance	Strict: National Parks, National Sanctuaries Non-strict: Reserves in which sustainable use is permitted	Non-strict PAs had lower rates of deforestation and lower levels of human disturbance compared to strict PAs.	[22]

Year	Study region	Index used	IUCN Categories	Conclusions	Reference
2016	Global	Species richness and abundance of vertebrates, invertebrates, and plants.	Strict: I-II Non-strict: III-VI	There was no statistically significant difference between strict and non-strict PAs.	[23]
2016	Brazil (Atlantic and Amazon forests)	Deforestation	Strict: I-IV Non-strict: V-VI	Strict PAs had lower rates of habitat conservation compared to non-strict PAs.	[24]
2017	Global (tropical forests)	Deforestation	Each IUCN category was analyzed separately	Deforestation rates within the various IUCN categories differed substantially across regions.	[25]
2018	Global	Human footprint index	Strict: I-II Non-strict: III-VI	Strict PAs tended to be under lower human pressure. However, the differences in the increases of human pressure were small (although size was important).	[26]
2018	Central America	Normalized Difference Vegetation Index (NDVI)	Strict: I-II Non-strict: III-VI	Strict and non-strict PAs were both effective in avoiding deforestation.	[27]
2019	Global (Last wilderness regions)	Human footprint index	Strict: I-II Non-strict: III-VI	There was no statistically significance difference between strict and non-strict PAs.	[28]
2019	East Africa	Habitat conversion (measured using changes in land-cover)	Strict: I-IV Non-strict: V-VI	Land-cover changes were lower within strict PAs.	[29]
2019	Colombia	Deforestation	Strict: I-IV Non-strict: V-VI	Strict PAs were more effective than non-strict PAs at reducing deforestation rates.	[30]

Year	Study region	Index used	IUCN Categories	Conclusions	Reference
2020	North America	Mortality rates of mammals	Each IUCN category was analyzed separately	There was no difference in the mortality rates of mammals between the various categories of PAs.	[31]
2020	Global	Deforestation	Each IUCN category was analyzed separately but were also analyzed as follows: Strict: I-III Non-Strict: IV-VI	The effectiveness of the protected areas in each category varied substantially among regions.	[32]
2020	Global	Alien animal species richness	Each IUCN category was analyzed separately	There was no obvious relationship between the number of alien animal species established and the IUCN categories. PAs in Category II had the highest number of alien species richness.	[33]
2020	Global	Deforestation	Each IUCN category was analyzed separately	Strict PAs (e.g., in Categories Ia and Ib) experienced lower rates of forest loss compared to non-strict PAs (e.g., in Categories IV and VI).	[34]
2020	Global	Mammal population declines driven by illegal hunting	Strict: I-II Non-strict: III-IV Categories V-VI were excluded from the analysis	Mammal populations across the globe had lower probabilities of decline in strict PAs compared to non-strict PAs.	[35]
2020	Global	Land productivity	Each IUCN category was analyzed separately	Land productivity was most stable in PAs in Categories III and VI and most unstable in PAs in Category V.	[36]

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Table S2. Mean values for each of the confounding variables included in the analysis. NC = protected areas with no IUCN category

IUCN Category	Area (km^2)	Elevation (m)	Slope (degree)	Nearest city (km)	Human footprint in 1993	Forest cover in 2000 (%)
Afrotropical						
Ia	420	826	8.39	71	5.8	76.5
Ib	7454	1168	6.07	73	6.7	76.9
II	3326	898	3.61	78	5.9	51.3
III	697	972	2.10	52	6.5	45.7
IV	2952	700	4.45	86	6.0	67.5
V	791	914	3.28	66	7.6	33.0
VI	3174	822	2.18	108	6.5	45.5
NC	328	768	3.02	73	8.0	55.9
Australasian						
Ia	350	290	2.35	310	4.7	48.1
Ib	333	565	8.11	162	1.7	86.9
II	849	327	4.89	300	4.5	70.7
III	44	351	6.90	147	4.3	71.0
IV	130	457	6.93	143	6.5	59.7
V	224	355	7.61	100	4.6	78.7
VI	1638	240	2.49	273	4.3	56.0
NC	1409	330	4.69	150	5.2	61.4
Indomalayan						
Ia	299	443	8.46	106	7.3	92.1
Ib	77	127	3.20	57	11.1	75.3
II	623	586	8.13	74	8.6	77.5
III	7	104	1.32	115	11.3	96.0
IV	451	543	5.67	103	11.5	52.2
V	154	375	6.60	140	12.5	63.3
VI	1110	655	9.12	75	7.4	86.2
NC	695	432	4.79	102	11.6	57.4
Nearctic						
Ia	67	1100	8.90	246	2.3	70.5
Ib	569	1576	9.02	204	2.3	51.6
II	809	790	5.87	225	4.4	68.0
III	11	417	3.95	128	12.0	69.2
IV	1003	342	1.26	138	10.1	41.4
V	126	563	3.63	148	7.1	57.7
VI	193	505	1.45	147	4.3	43.6

IUCN Category	Area (km^2)	Elevation (m)	Slope (degree)	Nearest city (km)	Human footprint in 1993	Forest cover in 2000 (%)
NC	2363	574	3.62	157	7.9	50.0
Neotropical						
Ia	1177	464	4.07	150	6.1	74.8
Ib	15	967	6.87	62	10.7	59.0
II	1694	984	9.07	80	7.0	73.8
III	1574	1347	7.52	61	8.6	60.0
IV	410	616	7.14	64	7.4	70.0
V	1659	611	6.34	64	13.5	56.1
VI	1658	1037	7.44	83	7.3	77.7
NC	1621	863	5.97	106	7.8	68.8
Palearctic						
Ia	1000	716	6.88	92	5.9	58.6
Ib	235	420	3.03	119	3.2	56.3
II	897	705	7.57	75	8.9	53.7
III	39	271	2.63	94	8.5	52.3
IV	168	380	5.14	91	13.3	56.9
V	129	368	4.86	52	18.6	54.0
VI	782	521	5.41	95	12.6	51.4
NC	307	297	3.25	59	14.7	35.6

Table S3. Results of the generalized boosted models, comparing strictly protected areas (Categories I-VI) to: (a) areas in which multiple human uses are allowed (Categories V-VI) and, (b) areas with no IUCN category (NC). HFI = Human footprint index; LFC = Loss in forest cover (%).

Realm	Index	Category	Estimate	Std. Error	t-value	p-value
Afrotropical	HFI	I-VI vs. V-VI	-0.234	0.163	-1.429	0.153
	HFI	I-VI vs. NC	0.147	0.104	1.418	0.156
	LFC	I-VI vs. V-VI	0.214	0.682	0.313	0.754
	LFC	I-VI vs. NC	3.354	0.571	5.878	<0.001***
Australasian	HFI	I-VI vs. V-VI	0.202	0.291	0.693	0.488
	HFI	I-VI vs. NC	1.814	0.467	3.887	<0.001***
	LFC	I-VI vs. V-VI	-3.872	0.866	-4.471	<0.001***
	LFC	I-VI vs. NC	-3.888	1.375	-2.828	0.005**
Indomalayan	HFI	I-VI vs. V-VI	0.275	0.367	0.749	0.454
	HFI	I-VI vs. NC	0.411	0.497	0.826	0.409
	LFC	I-VI vs. V-VI	2.090	0.799	2.615	0.009**
	LFC	I-VI vs. NC	6.244	3.357	1.860	0.063
Nearctic	HFI	I-VI vs. V-VI	-0.104	0.054	-1.925	0.054
	HFI	I-VI vs. NC	0.325	0.237	1.372	0.170
	LFC	I-VI vs. V-VI	0.797	0.453	1.759	0.079
	LFC	I-VI vs. NC	-0.542	1.264	-0.428	0.668
Neotropical	HFI	I-VI vs. V-VI	0.064	0.127	0.509	0.611
	HFI	I-VI vs. NC	0.224	0.153	1.461	0.144
	LFC	I-VI vs. V-VI	0.814	0.344	2.368	0.018*
	LFC	I-VI vs. NC	1.243	0.372	3.340	0.001**
Palearctic	HFI	I-VI vs. V-VI	-0.074	0.096	-0.769	0.442
	HFI	I-VI vs. NC	0.194	0.164	1.182	0.237
	LFC	I-VI vs. V-VI	0.267	0.231	1.157	0.247
	DR	I-VI vs. NC	0.384	0.451	0.850	0.395

Table S4. Results of the generalized boosted models when the alternative method was used to classify strictly protected areas (Categories I-II) and multiple-use areas (Categories III-VI). NC = areas with no IUCN Category; HFI = Human footprint index; LFC = Loss in forest cover (%).

Realm	Index	Category	Estimate	Std. Error	t-value	p-value
Afrotropical	HFI	I-II vs. III-VI	-0.049	0.162	-0.305	0.760
	HFI	I-II vs. NC	0.179	0.119	1.506	0.132
	LFC	I-II vs. III-VI	-0.140	0.675	-0.208	0.835
	LFC	I-II vs. NC	3.308	0.704	4.700	<0.001***
Australasian	HFI	I-II vs. III-VI	0.402	0.119	3.381	0.001**
	HFI	I-II vs. NC	1.778	0.443	4.016	<0.001***
	LFC	I-II vs. III-VI	-4.289	1.256	-3.414	0.001**
	LFC	I-II vs. NC	-5.374	2.271	-2.366	0.018*
Indomalayan	HFI	I-II vs. III-VI	0.828	0.235	3.516	<0.001***
	HFI	I-II vs. NC	1.355	0.434	3.123	0.002*
	LFC	I-II vs. III-VI	1.819	0.816	2.230	0.026*
	LFC	I-II vs. NC	5.416	2.510	2.158	0.031*
Nearctic	HFI	I-II vs. III-VI	0.009	0.040	0.225	0.822
	HFI	I-II vs. NC	0.060	0.123	0.489	0.625
	LFC	I-II vs. III-VI	1.153	0.661	1.744	0.081
	LFC	I-II vs. NC	-1.507	1.051	-1.434	0.152
Neotropical	HFI	I-II vs. III-VI	0.268	0.108	2.478	0.013*
	HFI	I-II vs. NC	0.272	0.157	1.732	0.084
	LFC	I-II vs. III-VI	0.835	0.350	2.386	0.017*
	LFC	I-II vs. NC	1.284	0.391	3.284	0.001**
Palearctic	HFI	I-II vs. III-VI	0.137	0.074	1.842	0.066
	HFI	I-II vs. NC	0.392	0.177	2.217	0.027*
	LFC	I-II vs. III-VI	0.879	0.259	3.395	0.001*
	LFC	I-II vs. NC	1.099	0.860	1.278	0.201

Table S5. Results of the matching analysis comparing strictly protected areas to areas in which multiple human used are allowed. Comparisons were made using the Wilcoxon rank test. The total number of protected areas (PAs) and the number of matched areas are also shown.

Realm	Method	Statistic	p-value	PAs total	PAs matched
Human footprint index					
Afrotropical	I-VI vs. V-VI	-0.771	0.441	553	288
Australasian	I-VI vs. V-VI	0.807	0.420	1403	266
Indomalayan	I-VI vs. V-VI	0.862	0.389	861	226
Neartic	I-VI vs. V-VI	-4.165	<0.001***	3617	3456
Neotropical	I-VI vs. V-VI	3.065	0.002**	944	688
Paleartic	I-VI vs. V-VI	-12.148	<0.001***	7697	5226
Afrotropical	I-II vs. III-VI	0.826	0.409	553	472
Australasian	I-II vs. III-VI	3.859	<0.001***	1403	1100
Indomalayan	I-II vs. III-VI	4.989	<0.001***	861	788
Neartic	I-II vs. III-VI	-1.406	0.160	3617	2576
Neotropical	I-II vs. III-VI	3.511	<0.001***	944	792
Paleartic	I-II vs. III-VI	1.062	0.288	7697	1828
Loss in forest cover (%)					
Afrotropical	I-VI vs. V-VI	-0.072	0.942	423	230
Australasian	I-VI vs. V-VI	1.608	0.108	1149	218
Indomalayan	I-VI vs. V-VI	-3.617	<0.001***	775	224
Neartic	I-VI vs. V-VI	-2.409	0.016*	3178	3086
Neotropical	I-VI vs. V-VI	-4.714	<0.001***	873	628
Paleartic	I-VI vs. V-VI	-7.371	<0.001***	7413	5092
Afrotropical	I-II vs. III-VI	-0.219	0.827	423	372
Australasian	I-II vs. III-VI	5.486	<0.001***	1149	886
Indomalayan	I-II vs. III-VI	-0.121	0.904	775	770
Neartic	I-II vs. III-VI	-4.465	<0.001***	3178	2158
Neotropical	I-II vs. III-VI	-6.053	<0.001***	873	762
Paleartic	I-II vs. III-VI	-7.292	<0.001***	7413	1694

Figure S1. Differences in the change in human footprint between strictly protected areas (1) and matched areas in which multiple human uses are permitted (0). Strictly protected areas represent Categories I-VI and multiple-use areas represent Categories V-VI. Negative numbers indicate a decrease in human footprint.

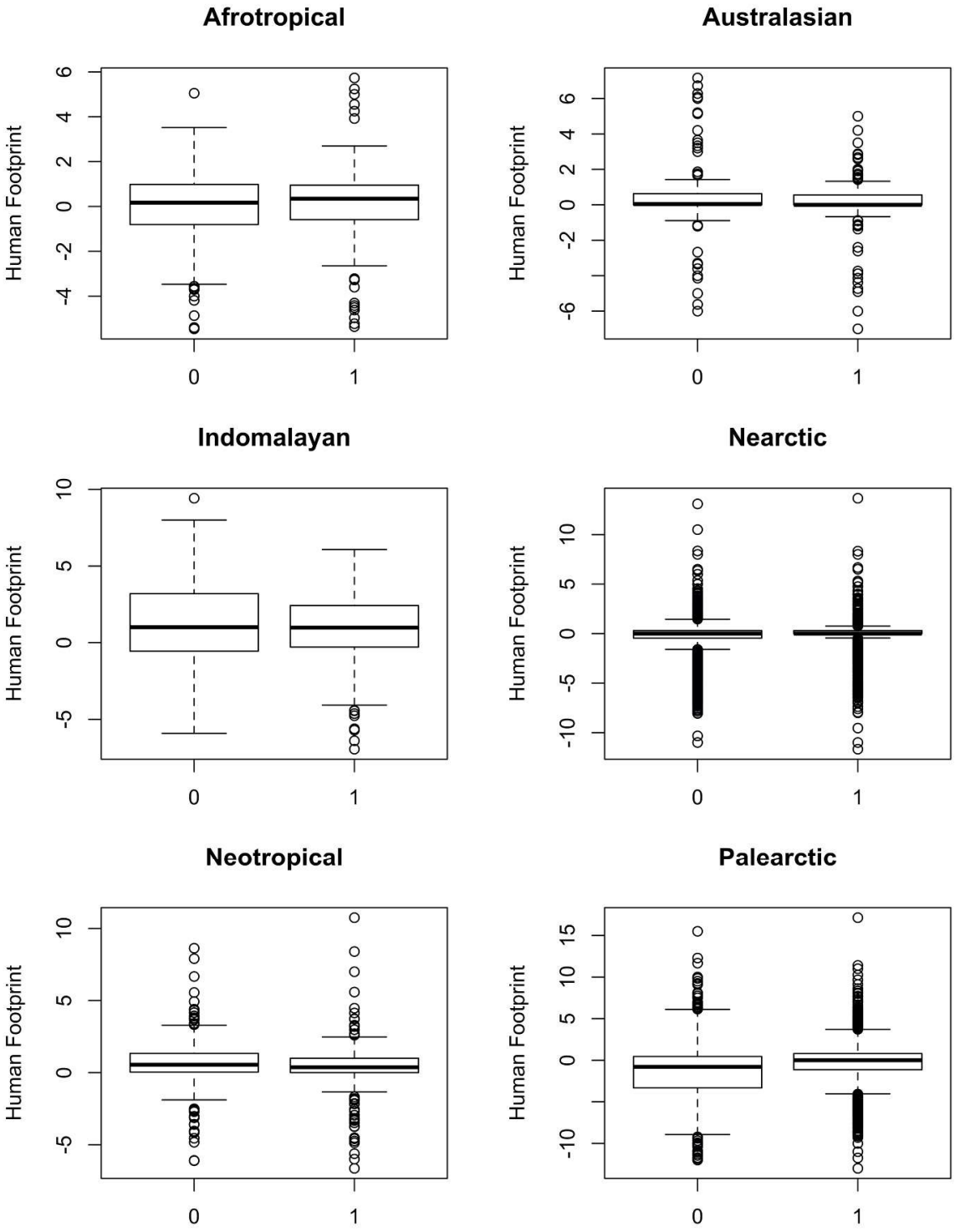

Figure S2. Differences in the change in human footprint between strictly protected areas (1) and matched areas in which multiple human uses are permitted (0). Strictly protected areas represent Categories I-II and multiple-use areas represent Categories III-VI. Negative numbers indicate a decrease in human footprint.

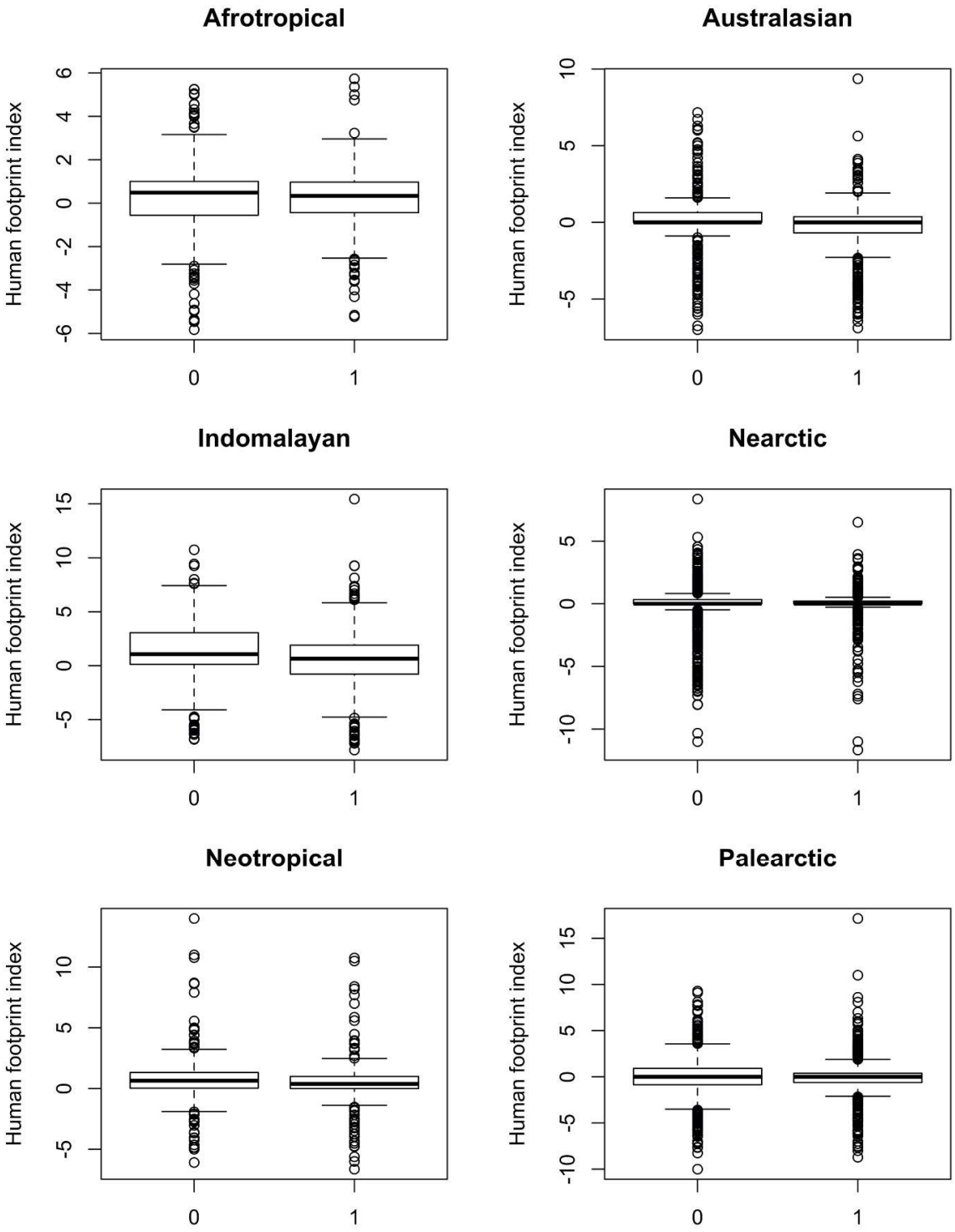

Figure S3. Differences in forest cover loss (%) between strictly protected areas (1) and matched areas in which multiple human uses are permitted (0). Strictly protected areas represent Categories I-IV and multiple-use areas represent Categories V-VI.

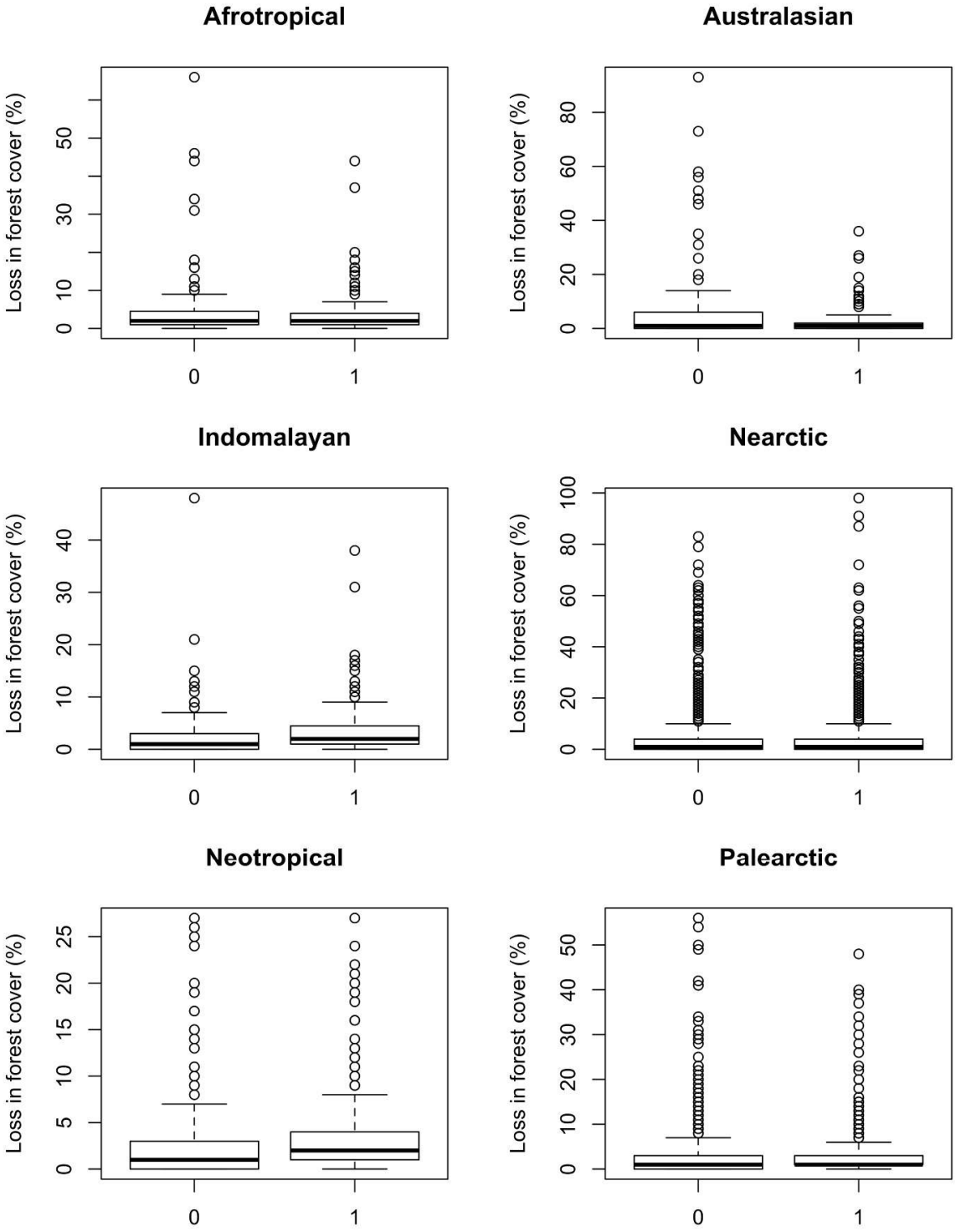

Figure S4. Differences in forest cover loss (%) between strictly protected areas (1) and matched areas in which multiple human uses are permitted (0). Strictly protected areas represent Categories I-II and multiple-use areas represent Categories III-VI.

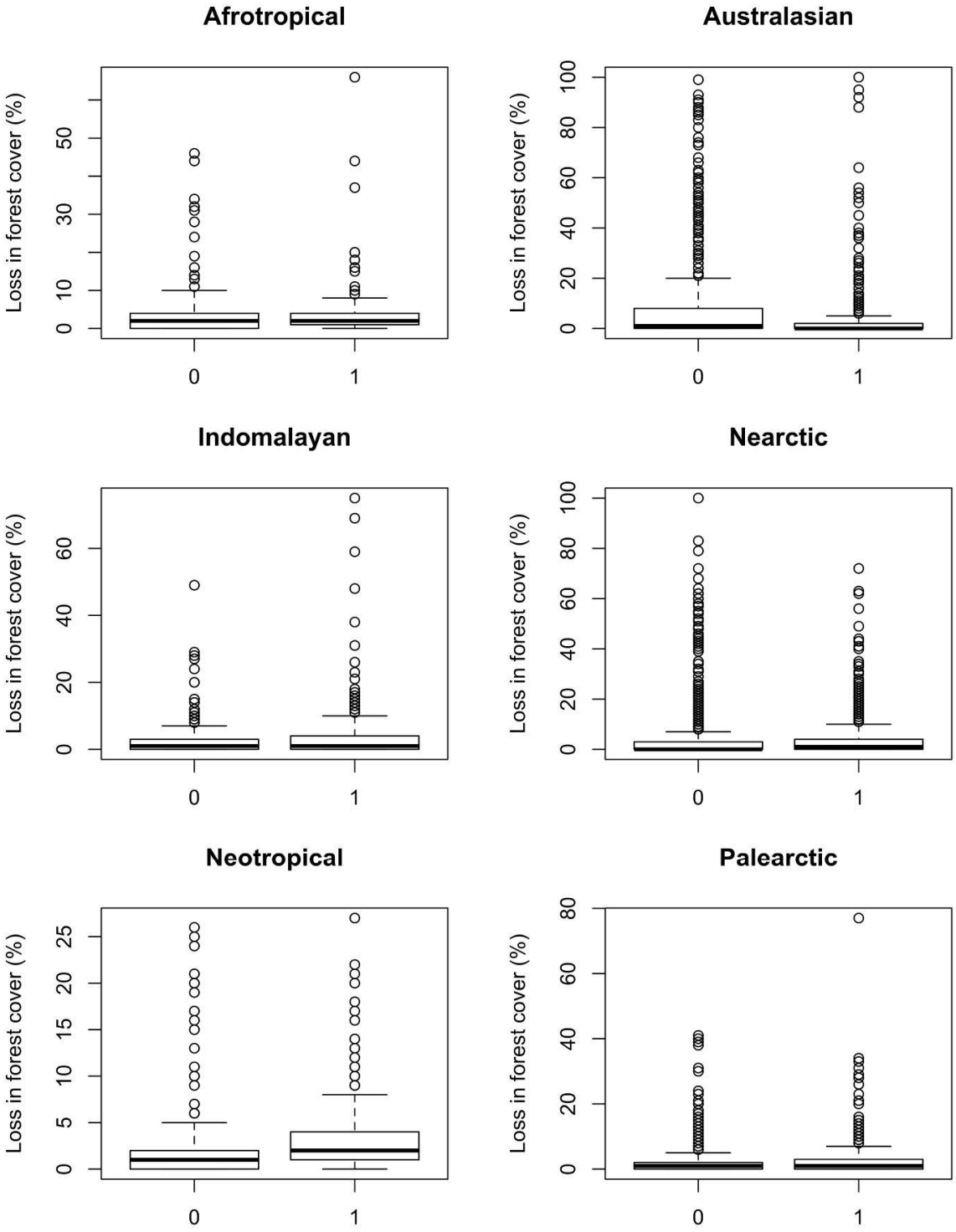

Figure S5. The resulting balance when generalized boosted models were used to compare the three types of protected areas, using the human footprint index and by grouping protected areas as follows: strictly protected = Categories I-IV, multiple-use = Categories V-VI. Unweighted values represent the differences between the treatment groups, for each of the confounding variables, based on the raw data. Solid circles indicate that differences were statistically significant at the 0.05 level.

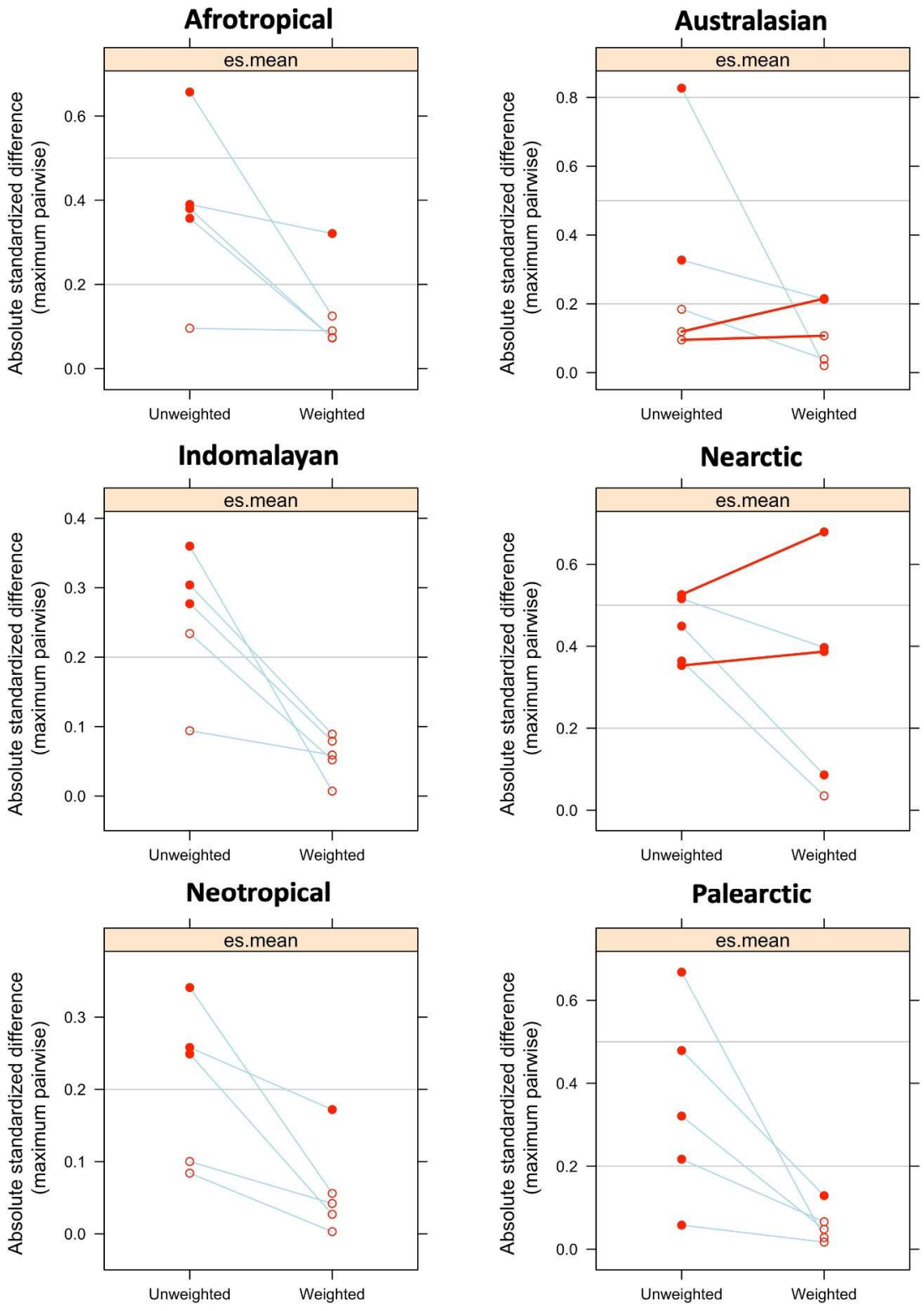

Figure S6. The resulting balance when generalized boosted models were used to compare the three types of protected areas, using the human footprint index and by grouping protected areas as follows: strictly protected = Categories I-II, multiple-use = Categories III-VI.

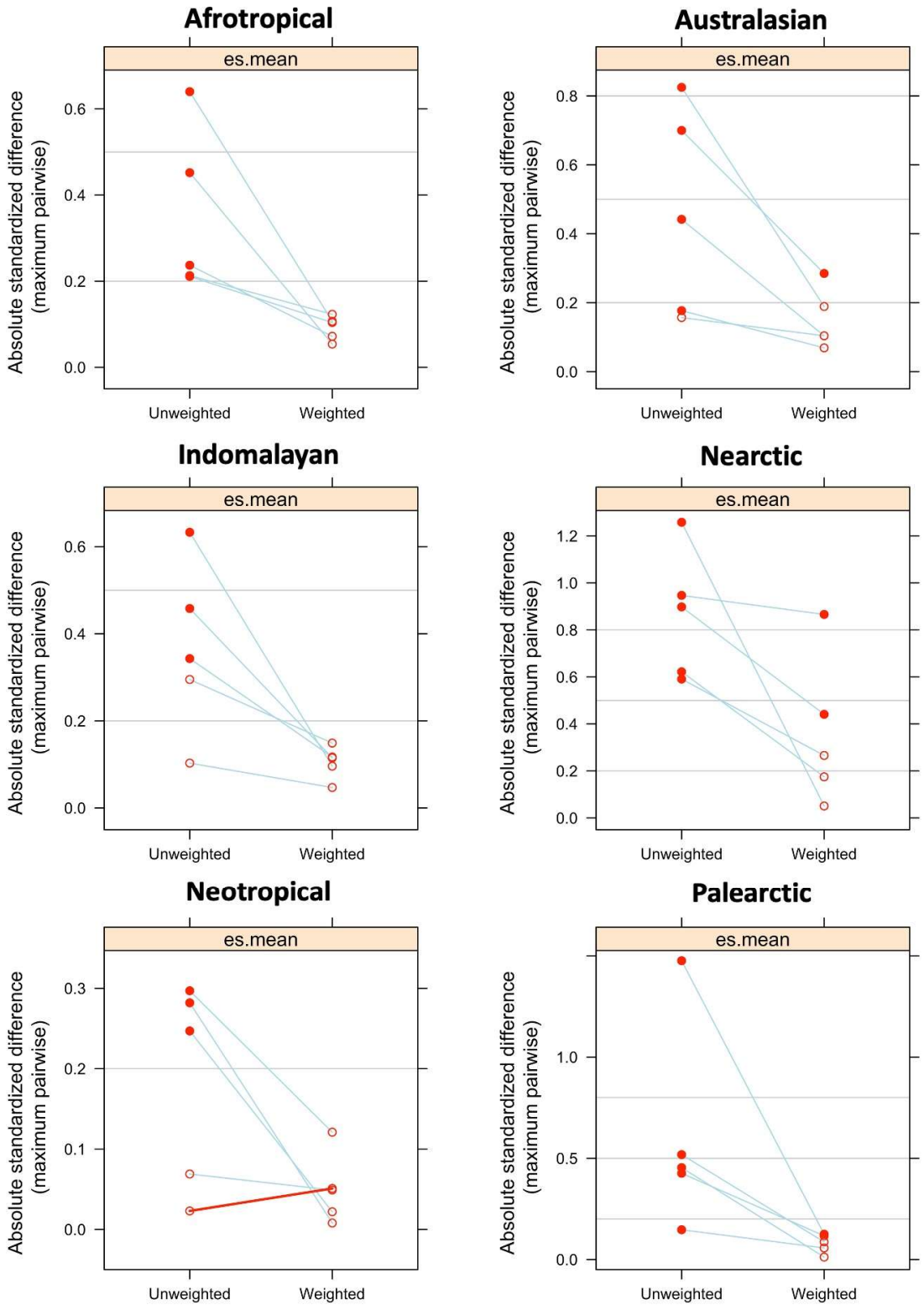

Figure S7. The resulting balance when generalized boosted models were used to compare the three types of protected areas, using the loss in forest cover (%) and by grouping protected areas as follows: strictly protected = Categories I-IV, multiple-use = Categories V-VI.

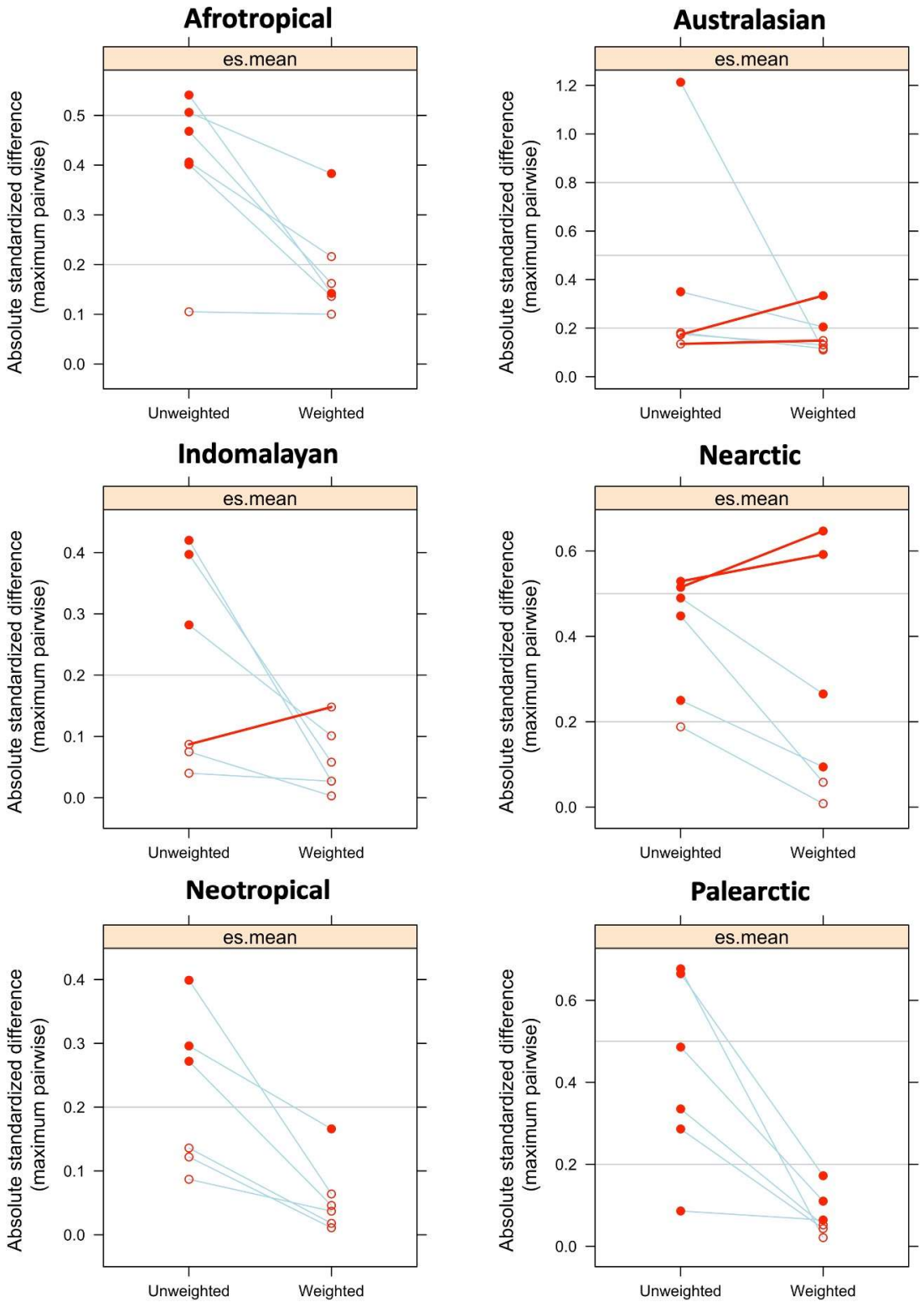

Figure S8. The resulting balance when generalized boosted models were used to compare the three types of protected areas, using the loss in forest cover (%) and by grouping protected areas as follows: strictly protected = Categories I-II, multiple-use = Categories III-VI.

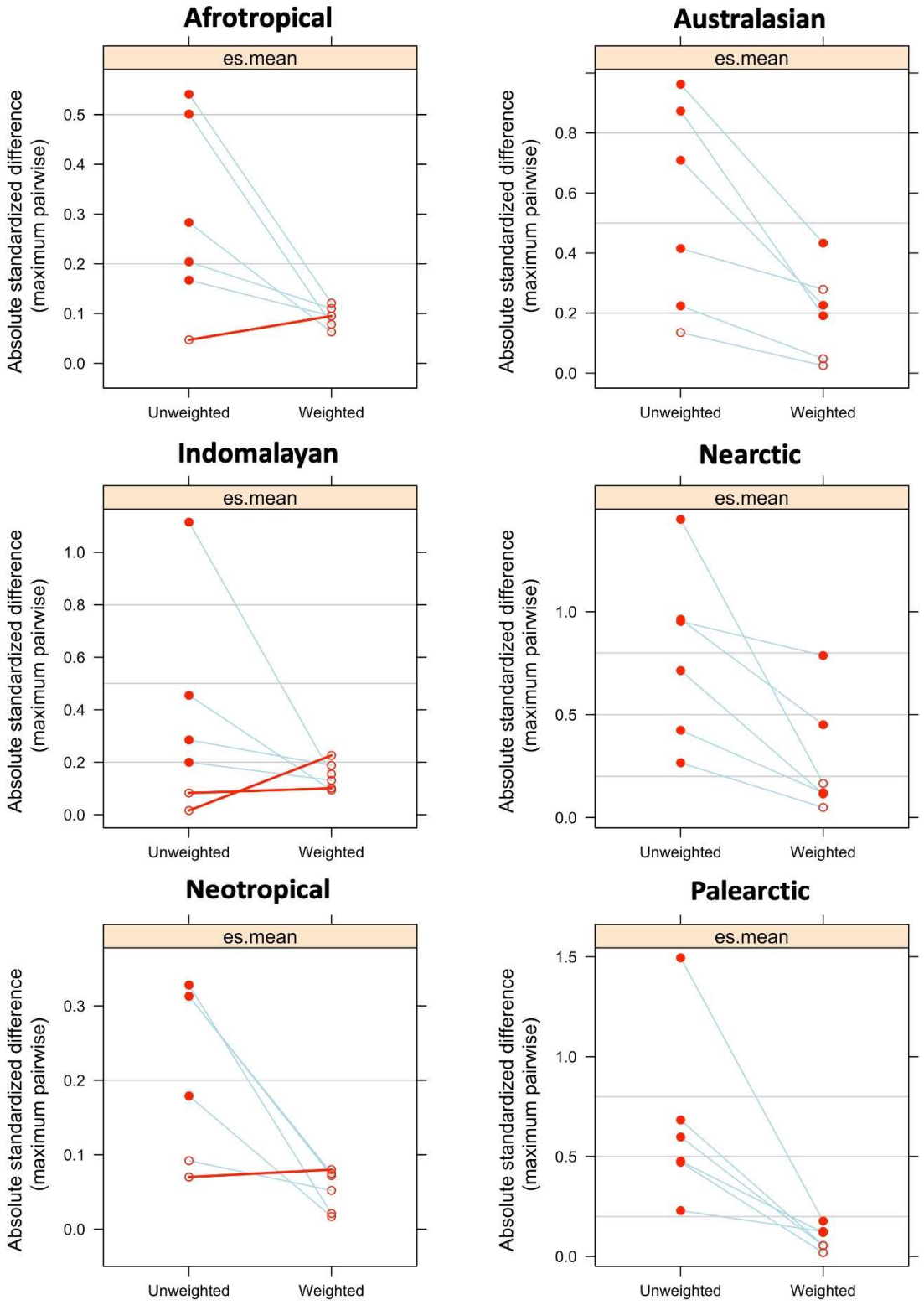

Figure S9. The resulting balance when matching was used to compare the protected areas, using the human footprint index and by grouping protected areas as follows: strictly protected = Categories I-IV, multiple-use = Categories V-VI.

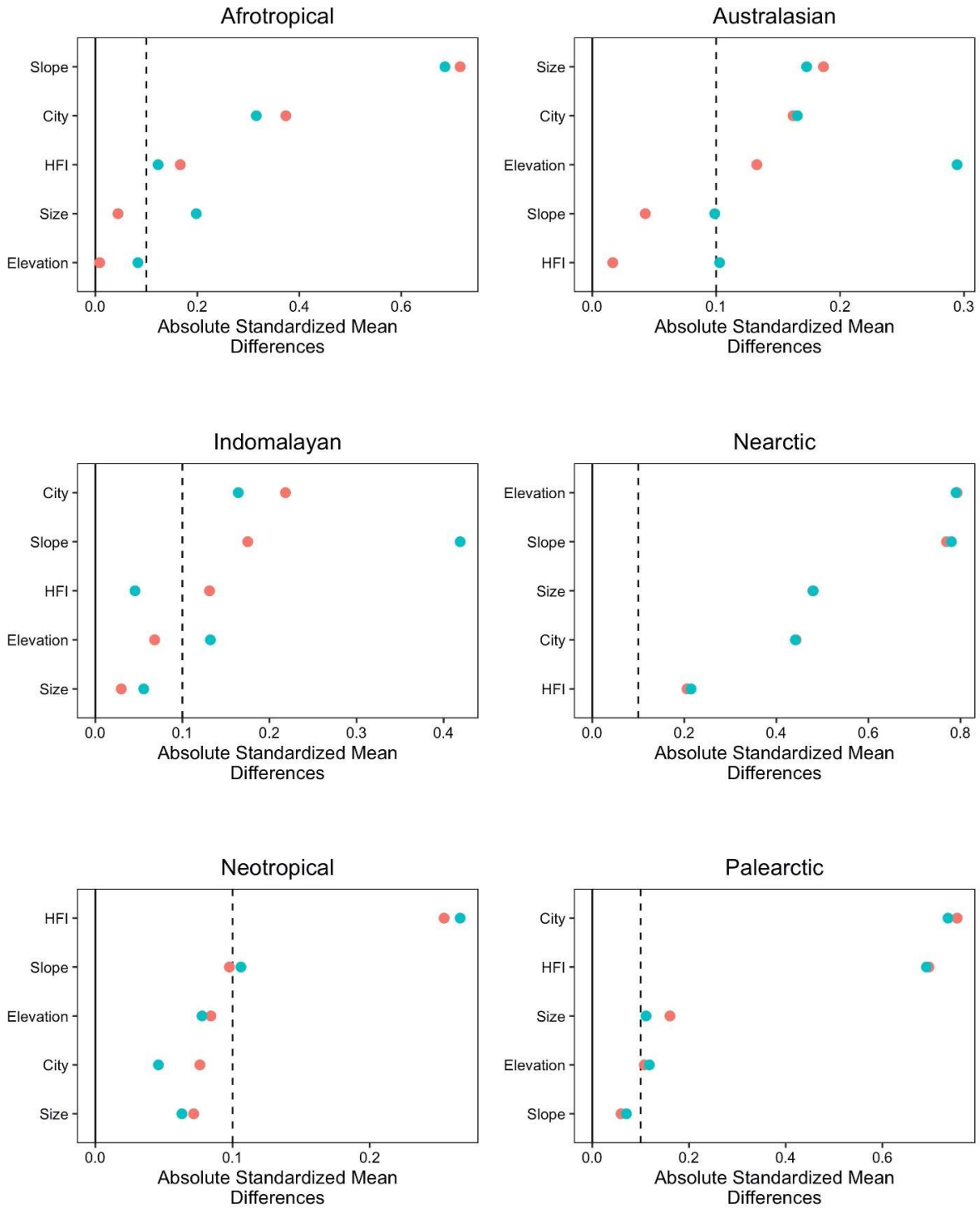

Figure S10. The resulting balance when matching was used to compare the protected areas, using the human footprint index and by grouping protected areas as follows: strictly protected = Categories I-II, multiple-use = Categories III-VI.

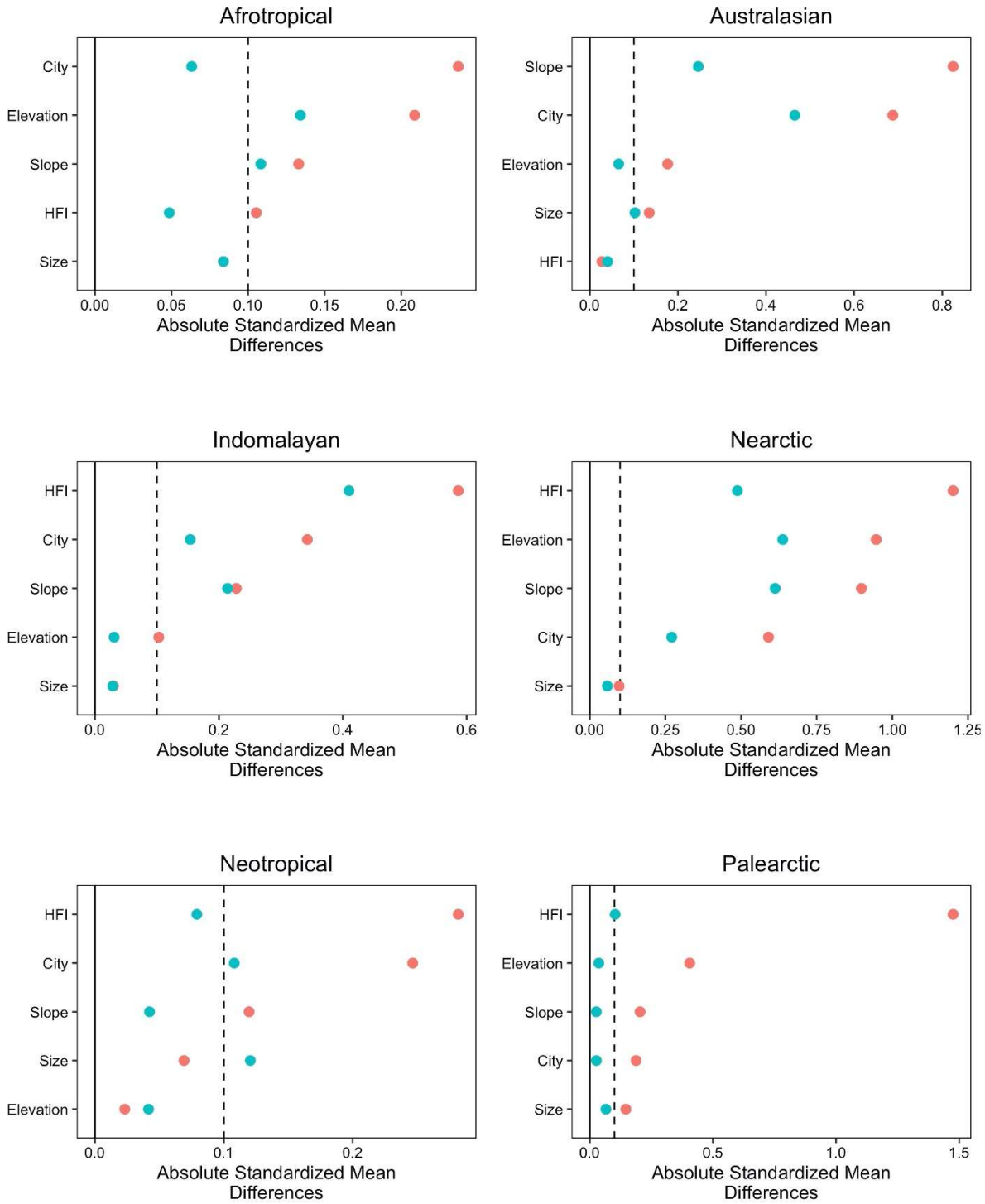

Figure S11. The resulting balance when matching was used to compare the protected areas, using the loss in forest cover (%) and by grouping protected areas as follows: strictly protected = Categories I-IV, multiple-use = Categories V-VI.

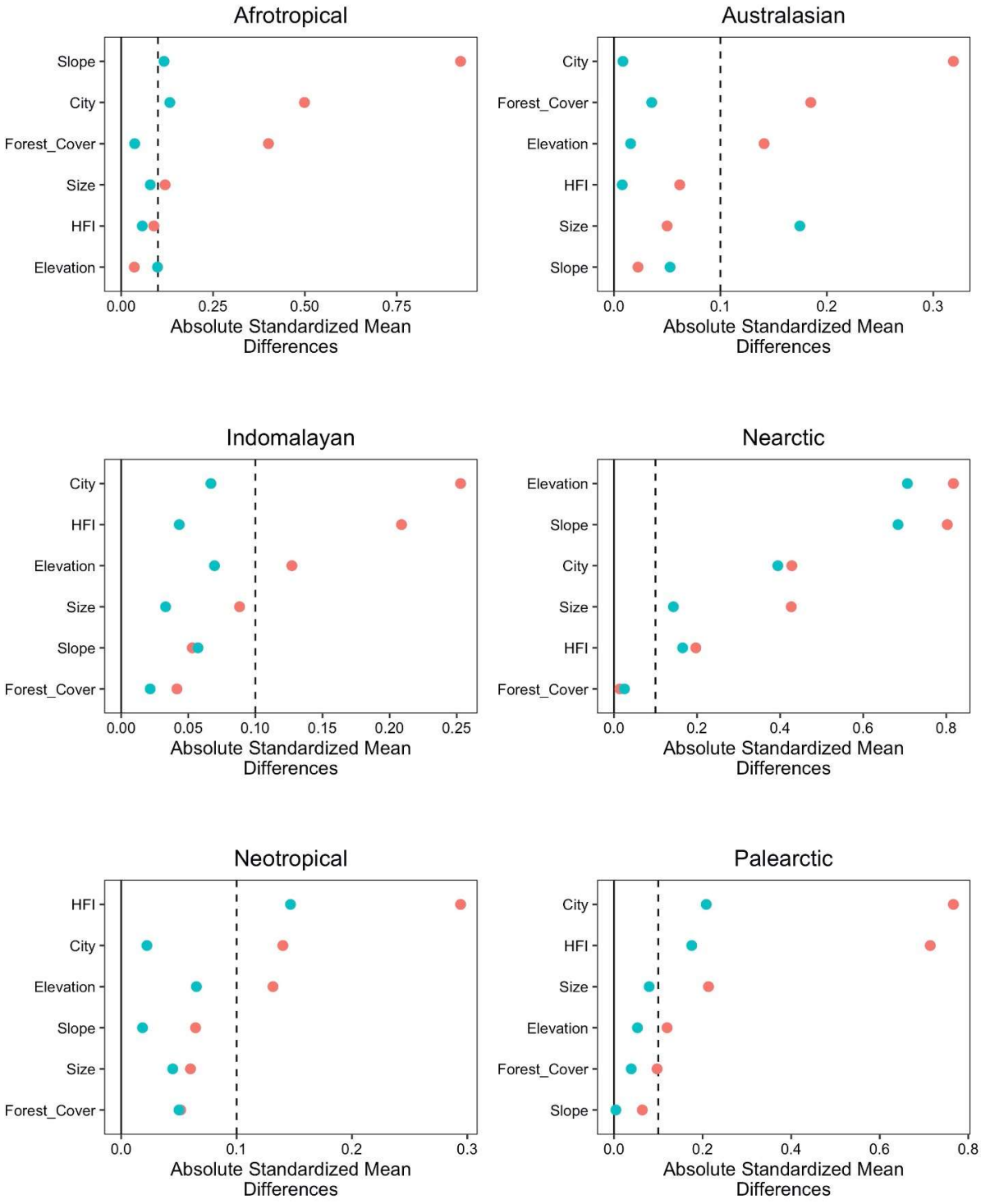

Figure S12. The resulting balance when matching was used to compare the protected areas, using the loss in forest cover (%) and by grouping protected areas as follows: strictly protected = Categories I-II, multiple-use = Categories III-VI.