Supporting information

Non-specific Freshwater Protected Areas conserve cichlid fish taxonomic and trophic diversity in Lake Tanganyika, with particular benefit to herbivores

CONTENTS

Appendix S1. Study site descriptions

The Tanzania shoreline was selected as it includes several FPAs, although the majority of this coast (as with the rest of the lake) is unprotected regarding both terrestrial and aquatic habitats (Allison 2000) and has been subject to varied anthropogenic impacts (Global Forest Watch 2000). Importantly, this coastline avoids within country political instability (DRC, Burundi, which includes Rusizi NP), and dangerous wildlife (Nsumbu NP, Zambia). Human settlements along the selected shoreline vary in size from isolated fishing communities, small villages, to the large urban area of Kigoma Town, which holds the largest human population on the eastern side of the lake (Worldpop, 2013). Two protected areas in the Kigoma region that conserve both the lakeshore Miombo woodland and littoral zone (Coulter & Mubamba 1993) include Gombe Stream National Park (Gombe NP) and Mahale Mountain National Park (Mahale NP) (West 2001), however, the scale and level of protection varies greatly, with Mahale NP representing the largest area of protected coastline containing a no take fishing zone that extends 1.6km off the coast covering an area of 96km^2 (Sweke et al. 2013), while conversely, Gombe NP is much smaller, protecting 35km^2 of forest, and provided no protection until 2015 when a no take zone was introduced.

Kigoma Town: HD rank 7.

Kigoma Town, the capital of the Kigoma region, has a human population of 215,458 (GeoHive 2012), and serves as the largest transit port for people and goods on LT (Lake Tanganyika Authority 2012). Rural to urban migration and refugee immigration has increased Kigoma Town's population dramatically (National Bureau of Statistics 2011), resulting in a population density of over three people per 100m^2 (Worldpop 2013). Increased watershed deforestation has caused a reduction in tree cover to less than 10% canopy density (Global Forest Watch 2000), and consequently increased runoff into the lake, where visible layers of sediment now covers rocks in the littoral zone (McIntyre *et al.* 2005). In addition, the rising population has increased fishing effort in Kigoma Bay for subsistence and commercial purposes (Kimirei, Mgaya & Chande 2008). The shoreline of Kigoma Town is ~8km and encompasses underwater cliffs, large boulders, rocky patches and bedrock, intercepted by three small sandy bays.

Kigoma Deforested: HD rank 6.

To the south of Kigoma Town the urban area gives way to 1km of deforested shoreline with a population of less than three people per $100m^2$ (Worldpop 2013). Tree canopy density is approximately 10% (Global Forest Watch 2000), and because of the areas close proximity to Kigoma Town, fishing pressures are high (Kimirei, Mgaya & Chande 2008). The littoral zone is rocky, comprising large boulders, smaller rocky patches and bedrock.

Jakobsen's Beach: HD rank 5.

Jakobsen's Beach, directly south of the Kigoma Deforested site, is a private reserve covering 1km of shoreline, with a population of less than three people per $100m^2$ (Worldpop 2013). Reforestation has resulted in scrubby tree cover of approximately 20% canopy density (Global Forest Watch 2000). Similarly to Kigoma Deforested, fishing pressure is high due to the areas close proximity to Kigoma Town (Kimirei, Mgaya & Chande 2008). The littoral zone has two small sandy bays and large rocky areas including large boulders and smaller rocky patches.

Kalilani Village: HD rank 4.

Kalilani Village, immediately north of Mahale NP, is a small fishing village encompassing 2km of shoreline, and has a population of less than three people per $100m^2$ (Worldpop 2013). Basic human habitation and small scale agriculture has resulted in a reduction in tree cover to approximately 25% canopy density (Global Forest Watch 2000). Artisanal fisheries dominate due to the nature of the small human population although fishing effort has increased since the exclusion zone was established in Mahale NP (Allison 2000). The littoral zone is made up of rocky areas with large boulders and smaller rocky patches interspersed with small sand patches.

Gombe NP: HD rank 3.

Gombe Stream NP (IUCN category 2) is a protected $35km^2$ strip of semi-deciduous and evergreen forest, thicket and grassland (Pusey *et al.* 2007) stretching along 12km of lake shore, 11km north of Kigoma Town (Allison 2000). Gombe was declared a National Park in 1968 (Pusey *et al.* 2007), however, the park boundary ends 100 metres short of the shoreline so forest has been cleared (Allison, Lubchenco & Carr 1998), contributing to the park having approximately 50% tree canopy density (Global Forest Watch 2000).

A small number of park staff and tourists enter the park daily, but it is essentially uninhabited (Pusey, Wilson & Anthony Collins 2008). However, Gombe NP's small size makes it vulnerable to edge effects at the borders and the waters north of the park are particularly at risk because of the presence of a large fishing village (McIntyre *et al.* 2005). The northern littoral zone includes underwater cliffs, large boulders, rocky patches and bedrock, whilst rocky shores are interspersed with sand through the middle of the park, before turning rocky from the shore to a depth of five metres in the south.

Mahale Mountain NP

Mahale Mountain National Park (IUCN category 2) was established in 1985 and lies 140km south of Kigoma Town (Pusey *et al.* 2007) and protects 1,517km^2 of forest (Sweke *et al.* 2013). The majority of the park has a tree canopy density of approximately 75% (Global Forest Watch 2000). There is a 96km^2 fishing exclusion zone stretching 1.6km into the lake along the parks 60km shoreline (West 2001) that represents half of the total protected water in LT (Allison *et al.* 2000). The parks' remoteness and high penalties for fishing ensures that the littoral zone is well protected (Allison 2000). The park is uninhabited apart from a small number of park staff and tourists (Kaur *et al.* 2008). Within Mahale NP there are patches of sand interspersed between large distances of rocky shore. As large discontinuities of rocky habitat can be a barrier to LT cichlid dispersal (e.g. Sefc *et al.* 2007; Wagner & McCune, 2009) Mahale NP was split into two sites; Mahale Site 1 (Mahale S1) and Mahale Site 2 (Mahale S2) due to the presence of sandy patch between them (see also results).

Mahale S1: HD rank 1.5.

Mahale S1 covers 7km of shoreline near the northern border of the park, its littoral zone is comprised of underwater cliffs, large boulders and rocky patches interspersed with small sandy bays.

Mahale S2: HD rank 1.5.

Mahale S2 lies 6km directly south of Mahale S1, separated by a 4km stretch of sand interspersed with small rocky patches. The site covers 5km of shoreline and its littoral zone is very similar to Mahale North, with underwater cliffs, large boulders and rocky patches, but with fewer sandy bays.

Table S1. Human disturbance (HD) factors and relative rank for each site on a scale of 1 (low disturbance) to 7 (high disturbance)

Site	Tree canopy density (%)*	Water protection (0 = not protected, 1 = protected)†	Population density (per 100m^2)‡	Relative HD rank
Kigoma Town	0	0	>3	7
Kigoma Deforested	10	0	<3	6
Jakobsen's Beach	20	0	<3	5
Kalilani Village	25	0	<3	4
Gombe NP	50	0	<3	3
Mahale S1	75	1	<3	1.5
Mahale S2	75	1	<3	1.5

*****(Global Forest Watch 2000)**;** †(Allison 2000)**;** ‡(Worldpop 2013)

Table S2. Cichlid species observed across all surveys detailing taxonomy, diet, habitat and brooding-type. Tribal classsification based on Meyer, Matschiner & Salzburger (2014), and species classification according to Eschmeyer (2015) with names in parenthesis denoting possible future taxonomic revision (Konings 2015). Trophic groups: I, invertivore; H, herbivore; P, piscivore, for each species were assigned where possible based on stomach contents containing >50% of items of that dietary group (data taken from the literature). Where stomach content information was not available the major dietary component stated in the literature was used to assign trophic group. Three species were not assigned a group as they were scale-eaters. Parental care abbreviations: SB, substrate brooding; MB, mouth brooding; bi, biparental, m, maternal.

Species	Major dietary components	Trophic group	Water column habitat[c]	Substrate habitat[c]	Parental care[c]
LAMPROLOGINI					
Altolamprologus compressiceps	Crustaceans[a,b]	I	Benthic	Rock	SB
Chalinochromis brichardi	Invertebrates[c]	I	Benthic	Rock	SB
Chalinochromis popelini	Invertebrates[c]	I	Benthic	Rock	SB
Julidochromis regani	Sponges[b]	I	Benthic	Rock	SB
Lamprologus callipterus	Crustaceans, insect larvae[a,b]	I	Benthic	Sand, rock	SB
Lamprologus lemairii	Fish, fry[b]	P	Water column	Rock, sand	SB
Lepidiolamprologus attenuatus	Fish[c]	P	Water column	Rock, sand	SB
Lepidiolamprologus cunningtoni	Fish[c]	P	Water column	Sand, rock	SB
Lepidiolamprologus elongatus	Fish, fry[b]	P	Water column	Rock	SB
Lepidiolamprologus profundicola	Fish, fry[b]	P	Water column	Rock	SB
Neolamprologus brichardi	Invertebrates[b]	I	Water column	Rock	SB
Neolamprologus falcicula	Invertebrates[c]	I	Water column	Rock	SB
Neolamprologus fasciatus	Fish, fry[b]	P	Water column	Rock	SB
Neolamprologus furcifer	Crustaceans, insect larvae[a,b]	I	Benthic	Rock	SB
Neolamprologus gracilis	Invertebrates[c]	I	Water column	Rock	SB
Neolamprologus leleupi	Crustaceans, insect larvae[a,b]	I	Benthic	Rock	SB
Neolamprologus modestus	Crustaceans, insect larvae, gastropods[a,b]	I	Benthic	Sand, rock	SB
Neolamprologus mondabu	Gastropods, insect larvae[a,b]	I	Benthic	Sand, rock	SB
Neolamprologus niger	Crustaceans, insect larvae, gastropods[a,b]	I	Benthic	Sand, rock	SB
Neolamprologus savoryi	Invertebrates, plankton[b]	I	Water column	Rock	SB
Neolamprologus tetracanthus	Gastropods, insect larvae[a,b]	I	Benthic	Sand, rock	SB
Neolamprologus toae	Crustaceans, insect larvae[b]	I	Benthic	Rock	SB
Neolamprologus tretocephalus	Gastropods[b]	I	Benthic	Rock	SB
Telmatochromis dhonti	Fish, fry[c]	P	Water column	Sand, rock	SB
Telmatochromis temporalis	Aufwuchs browser, filamentous algae[d,e]	H	Benthic	Rock	SB
Telmatochromis vittatus	Aufwuchs browser[d]	H	Benthic	Rock	SB
TROPHEINI					
Gnathochromis pfefferi	Crustaceans[b]	I	Benthic	Rock, mud	MB m
Limnotilapia dardennii	Invertebrates, detritus[a,b,f]	I	Benthic	Rock	MB m
Lobochilotes labiatus	Crustaceans, insect larvae[g]	I	Benthic	Rock	MB m

Petrochromis famula	Aufwuchs grazer, unicellular algae[d,e]	H	Benthic	Rock	MB m
Petrochromis fasciolatus	Aufwuchs grazer, unicellular algae[d,e]	H	Benthic	Rock, sand	MB m
Petrochromis macrognathus	Aufwuchs grazer[d]	H	Benthic	Rock	MB m
Petrochromis orthognathus	Aufwuchs grazer, unicellular algae[e,h]	H	Benthic	Rock	MB m
Petrochromis polyodon	Aufwuchs grazer, unicellular algae[d,e]	H	Benthic	Rock	MB m
Petrochromis trewavasae	Aufwuchs grazer, unicellular algae[d,e]	H	Benthic	Rock	MB m
Pseudosimochromis curvifrons	Aufwuchs browser, filamentous algae[d,e]	H	Benthic	Rock, sand	MB m
Simochromis babaulti (*Pseudosimochromis babaulti*I	Aufwuchs browser[f]	H	Benthic	Rock	MB m
Simochromis diagramma	Aufwuchs browser, filamentous algae[d,e]	H	Benthic	Rock	MB m
Tropheus annectens	Aufwuchs browser[c]	H	Benthic	Rock	MB m
Tropheus brichardi	Aufwuchs browser[c]	H	Benthic	Rock	MB m
Tropheus duboisi	Aufwuchs browser[c]	H	Benthic	Rock	MB m
Tropheus moorii	Aufwuchs browser, filamentous algae[d,e]	H	Benthic	Rock	MB m
ECTODINI					
Aulonocranus dewindti	Invertebrates, plankton[c]	I	Water column	Sand, rock	MB m
Callochromis macrops	Crustaceans[c]	I	Benthic	Sand, rock	MB m
Cyathopharynx foai	Aufwuchs, phytoplankton, detritus[c]	H	Water column	Rock, sand	MB m
Cyathopharynx furcifer	Aufwuchs, phytoplankton, detritus[c]	H	Water column	Rock, sand	MB m
Ectodus descampsi	Invertebrates[c]	I	Water column	Sand, rock	MB m
Grammatotria lemairii	Molluscs, zoobenthos[c]	I	Benthic	Sand, rock	MB m
Microdontochromis tenuidentatus	Invertebrates[c]	I	Benthic	Rock	MB m
Ophthalmotilapia heterodonta (*Ophthalmotilapia paranasuta*)	Aufwuchs, phytoplankton, detritus[c]	H	Water column	Rock, sand	MB m
Ophthalmotilapia nasuta	Aufwuchs, unicellular algae[e]	H	Water column	Rock, sand	MB m
Ophthalmotilapia ventralis	Aufwuchs, phytoplankton, detritus[e]	H	Water column	Rock	MB m
Xenotilapia flavipinnis	Invertebrates[c]	I	Benthic	Sand, rock	MB (biparental)
Xenotilapia leptura	Aufwuchs, unicellular and filamentous algae, phytoplankton[e]	H	Benthic	Rock	MB (maternal)
Xenotilapia melanogenys	Invertebrates[c]	I	Benthic	Sand, rock	MB (maternal)
Xenotilapia papilio	Aufwuchs scooper[d]	H	Benthic	Rock	MB bi
Xenotilapia sima	Diptera[b]	I	Benthic	Sand, rock	MB m
Xenotilapia spilopterus	Invertebrates[c]	I	Benthic	Sand, rock	MB bi
PERISSODINI					
Haplotaxodon microlepis	Zooplankton[c]	I	Water column	Rock	MB bi
Perissodus microlepis	Fish scales[i]		Water column	Rock	MB bi
Plecodus paradoxus (*Perissodus paradoxus*)	Fish scales[c]		Water column	Rock, sand	MB bi
Plecodus straeleni (*Perissodus straeleni*)	Fish scales, eggs[j]		Water column	Rock	MB bi
ERETMODINI					
Eretmodus cyanostictus	Aufwuchs scraper, filamentous algae[d,e]	H	Benthic	Rock	MB bi
Spathodus marlieri	Aufwuchs scraper[k]	H	Benthic	Rock	MB m
Tanganicodus irsacae	Aufwuchs, filamentous algae[e]	H	Benthic	Rock	MB bi

BATHYBATINI					
Bathybates ferox	Fish[k]	P	Water column	Rock	MB m
BENTHOCHROMINI					
Benthochromis tricoti	Zooplankton[c]	I	Water column	Rock, mud	MB m
BOULENGEROCHROMINI					
Boulengerochromis microlepis	Fish[k]	P	Water column	Sand, rock	SB
CYPRICHROMINI					
Cyprichromis leptosoma	Zooplankton[k]	I	Water column	Rock	MB m
CYPHOTILAPIINI					
Cyphotilapia frontosa	Fish[k]	P	Water column	Rock	MB m
TILAPIINI					
Oreochromis tanganicae	Plants, detritus[d]	H	Benthic	Sand, rock	MB m

[a]Yamaoka, K. (1991); [b](Hori *et al.* 1993); [c](Brichard 1989); [d](Hata *et al.* 2014); [e](Takamura 1984); [f](Sturmbauer *et al.* 2003); [g](Kohda & Tanida 1996); [h](Sturmbauer, Mark & Dallinger 1992); [I](Nshombo, Yanagisawa & Nagoshi 1985); [j](Yanagisawa *et al.* 1990); [k](Wagner *et al.* 2009)

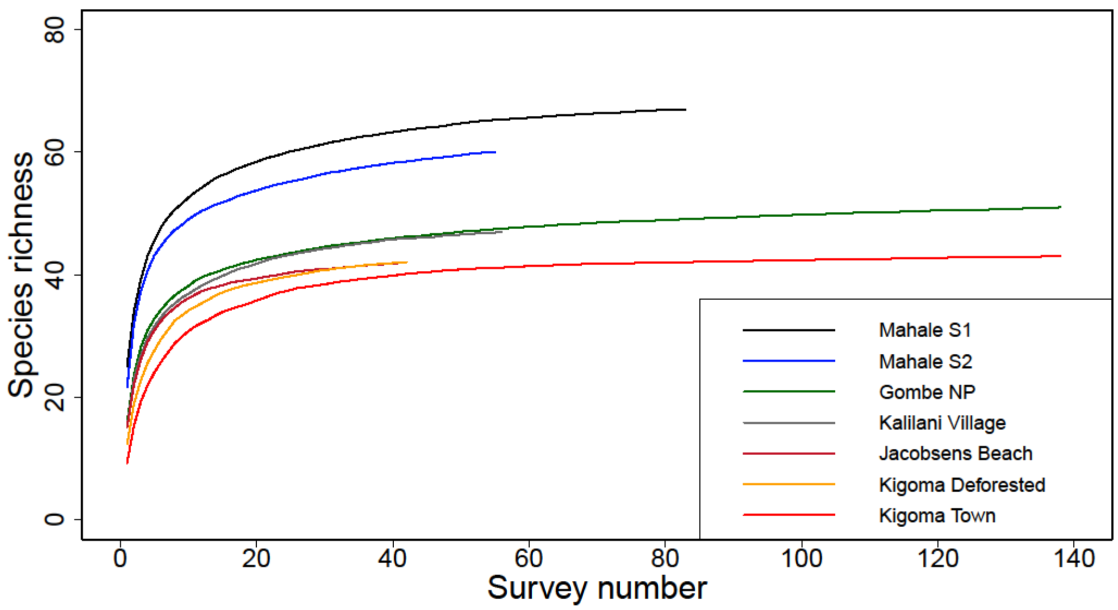

Figure S1. Species accumulation curves for all sites generated by plotting the cumulative number of species recorded at each site against sampling effort (Gombe NP, Kigoma Town, 138 surveys each; Mahale S1, 83 surveys; Kalilani Village, 56 surveys; Mahale S2, 55 surveys; Jakobsen's Beach, Kigoma Deforested, 42 surveys each).

Table S3. The distance decay in dissimilarity within each of the seven main sites surveyed. Mantel test values for significance of correlation between log-transformed Sørensen and Bray-Curtis dissimilarity and geographic distance between surveys within all sites. Bold *p*-values indicate significant ($p < 0.05$) distance decay relationships.

	Sørensen index		**Bray- Curtis index**	
Site	Pearson correlation	*P* value	Pearson correlation	*P* value
Kigoma Town	0.049	0.070	0.080	**0.001**
Kigoma Deforested	0.204	**0.001**	0.366	**0.001**
Jakobsen's Beach	0.211	**0.001**	0.190	**0.002**
Kalilani Village	0.165	**0.001**	0.142	**0.001**
Gombe NP	0.031	0.134	0.094	**0.002**
Mahale S1	0.082	**0.010**	0.008	0.337
Mahale S2	0.036	0.213	0.051	0.160

Table S4. AIC values for all sites zeta diversity decline model comparisons shown in Figure 2.

	AIC Value	
Site	**Exponential model**	**Power law model**
Kigoma Town	**-18.0**	4.95
Kigoma Deforested	**-29.5**	21.9
Jakobsen's Beach	**-32.3**	22.8
Kalilani Village	**7.14**	21.8
Gombe NP	-15.9	**-124.3**
Mahale S1	-34.8	**-158.1**
Mahale S2	-58.1	**-108.4**

Table S5. Correlation between relative HD rank and alpha and beta diversity values for the three main cichlid tribes and trophic groups. Rho and p values are given for Spearman's Rank Correlation. Asterisks indicate a significant positive or negative correlation (* $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$).

		ALPHA DIVERSITY				*BETA DIVERSITY*			
LAMPROLOGINI	**Relative human disturbance rank**	**Median species richness per survey**	**Median log abundance per survey (all species pooled)**	**Effective number of species per site**	**Pielou's evenness index per site**	**Sørensen dissimilarity value within site**	**Sørensen loss component (%)**	**Bray-Curtis dissimilarity value within site**	**Bray-Curtis loss component (%)**
Kigoma Town	7	6	1.81	6.13	0.63	0.413	39	0.717	47
Kigoma Deforested	6	7	1.96	4.57	0.54	0.388	36	0.667	42
Jakobsen's Beach	5	6	1.97	3.22	0.42	0.398	37	0.546	52
Kalilani Village	4	7	1.59	6.68	0.62	0.403	34	0.672	40
Gombe NP	3	7	1.89	7.81	0.68	0.366	37	0.584	41
Mahale S1	1.5	12	2.42	9.32	0.69	0.335	30	0.673	25
Mahale S2	1.5	9	2.24	7.49	0.65	0.345	34	0.694	34
Rho value		**-0.850**	-0.595	**-0.793**	-0.685	**0.847**	0.743	-0.054	**0.847**
***P* value**		0.016*	0.159	0.033*	0.09	0.0162*	0.0556	0.908	0.0162*

		ALPHA DIVERSITY				*BETA DIVERSITY*			
TROPHEINI	**Relative human disturbance rank**	**Median species richness per survey**	**Median log abundance per survey (all species pooled)**	**Effective number of species per site**	**Pielou's evenness index per site**	**Sørensen dissimilarity value within site**	**Sørensen loss component (%)**	**Bray-Curtis dissimilarity value within site**	**Bray-Curtis loss component (%)**
Kigoma Town	7	2	0.78	4.67	0.67	0.451	74	0.664	73
Kigoma Deforested	6	3	1	4.01	0.58	0.442	55	0.62	58
Jakobsen's Beach	5	5	1.19	7.66	0.85	0.415	40	0.577	26
Kalilani Village	4	4	0.98	7.42	0.87	0.379	39	0.542	36
Gombe NP	3	5	1.22	8.17	0.85	0.399	46	0.648	46
Mahale S1	1.5	6	1.43	7.71	0.74	0.298	36	0.523	43
Mahale S2	1.5	5	1.32	8.18	0.82	0.382	21	0.535	29
Rho value		**-0.860**	**-0.883**	**-0.865**	-0.345	**0.865**	**0.883**	**0.775**	0.505
***P* value**		0.013*	0.008**	0.012*	0.448	0.012*	0.0085**	0.041*	0.248

		ALPHA DIVERSITY				*BETA DIVERSITY*			
ECTODINI	**Relative human disturbance rank**	**Median species richness per survey**	**Median log abundance per survey (all species pooled)**	**Effective number of species per site**	**Pielou's evenness index per site**	**Sørensen dissimilarity value within site**	**Sørensen loss component (%)**	**Bray-Curtis dissimilarity value within site**	**Bray-Curtis loss component (%)**
Kigoma Town	7	0	0	4.29	0.66	0.304	76	0.57	80
Kigoma Deforested	6	2	1.17	3.98	0.63	0.399	39	0.738	39
Jakobsen's Beach	5	2	1.06	2.82	0.47	0.408	43	0.614	45
Kalilani Village	4	2	0.7	4.58	0.78	0.375	41	0.62	55
Gombe NP	3	2	1.29	3.92	0.62	0.395	50	0.77	55
Mahale S1	1.5	3	1.39	8.5	0.81	0.463	36	0.798	34

Mahale S2	1.5	3	1.26	5.25	0.67	0.431	45	0.763	41
Rho value		**-0.905**	**-0.793**	-0.559	-0.468	-0.703	0.288	**-0.829**	0.491
***P* value**		0.005**	0.033*	0.193	0.289	0.0782	0.531	0.021*	0.263

			ALPHA DIVERSITY			*BETA DIVERSITY*			
INVERTIVORES	**Relative human disturbance rank**	**Median species richness per survey**	**Median log abundance per survey (all species pooled)**	**Effective number of species per site**	**Pielou's evenness index per site**	**Sørensen dissimilarity value within site**	**Sørensen loss component (%)**	**Bray-Curtis dissimilarity value within site**	**Bray-Curtis loss component (%)**
Kigoma Town	7	5.5	1.82	7.17	0.64	0.468	37	0.776	41
Kigoma Deforested	6	6	2.09	4.1	0.46	0.423	30	0.751	36
Jakobsen's Beach	5	7	2.19	4.14	0.47	0.429	29	0.639	41
Kalilani Village	4	7	1.41	10.26	0.73	0.465	22	0.704	23
Gombe NP	3	7	1.72	10.22	0.74	0.457	27	0.706	29
Mahale S1	1.5	11	2.34	13.01	0.75	0.402	17	0.788	14
Mahale S2	1.5	9	2.33	6.81	0.58	0.413	32	0.755	32
Rho value		**-0.954**	-0.450	-0.505	-0.541	0.667	0.523	-0.216	0.745
***P* value**		0.0008***	0.310	0.248	0.210	0.102	0.229	0.641	0.054

			ALPHA DIVERSITY			*BETA DIVERSITY*			
HERBIVORES	**Relative human disturbance rank**	**Median species richness per survey**	**Median log abundance per survey (all species pooled)**	**Effective number of species per site**	**Pielou's evenness index per site**	**Sørensen dissimilarity value within site**	**Sørensen loss component (%)**	**Bray-Curtis dissimilarity value within site**	**Bray-Curtis loss component (%)**
Kigoma Town	7	2	1.17	5.21	0.64	0.469	59	0.733	59
Kigoma Deforested	6	4	1.19	5.89	0.67	0.522	38	0.78	41
Jakobsen's Beach	5	6	1.41	7.46	0.76	0.460	39	0.636	35
Kalilani Village	4	6	1.18	9.08	0.86	0.396	35	0.586	31
Gombe NP	3	6	1.59	6.65	0.68	0.426	46	0.726	45
Mahale S1	1.5	7	1.72	10.13	0.74	0.375	25	0.643	30
Mahale S2	1.5	7	1.64	12.04	0.83	0.416	31	0.67	31
Rho value		**-0.963**	**-0.883**	**-0.883**	-0.577	**0.829**	0.739	0.414	0.736
***P* value**		0.0005***	0.008**	0.008**	0.175	0.0211*	0.0579	0.355	0.059

			ALPHA DIVERSITY			*BETA DIVERSITY*			
PISCIVORES	**Relative human disturbance rank**	**Median species richness per survey**	**Median log abundance per survey (all species pooled)**	**Effective number of species per site**	**Pielou's evenness index per site**	**Sørensen dissimilarity value within site**	**Sørensen loss component (%)**	**Bray-Curtis dissimilarity value within site**	**Bray-Curtis loss component (%)**
Kigoma Town	7	2	1.18	2.19	0.44	0.271	63	0.531	65
Kigoma Deforested	6	2	1.04	1.59	0.26	0.264	57	0.562	72
Jakobsen's Beach	5	2	0.85	2.69	0.55	0.300	60	0.454	43
Kalilani Village	4	2	1.29	2.12	0.39	0.249	66	0.609	73

Gombe NP	3	3	1.43	2.51	0.42	0.264	56	0.451	65
Mahale S1	1.5	4	2.09	2.87	0.48	0.236	47	0.593	60
Mahale S2	1.5	3	1.43	3.23	0.56	0.303	60	0.617	58
Rho value		**-0.874**	**-0.827**	-0.739	-0.468	0.164	0.464	-0.432	0.345
***P* value**		0.01*	0.021*	0.058	0.289	0.726	0.295	0.333	0.448

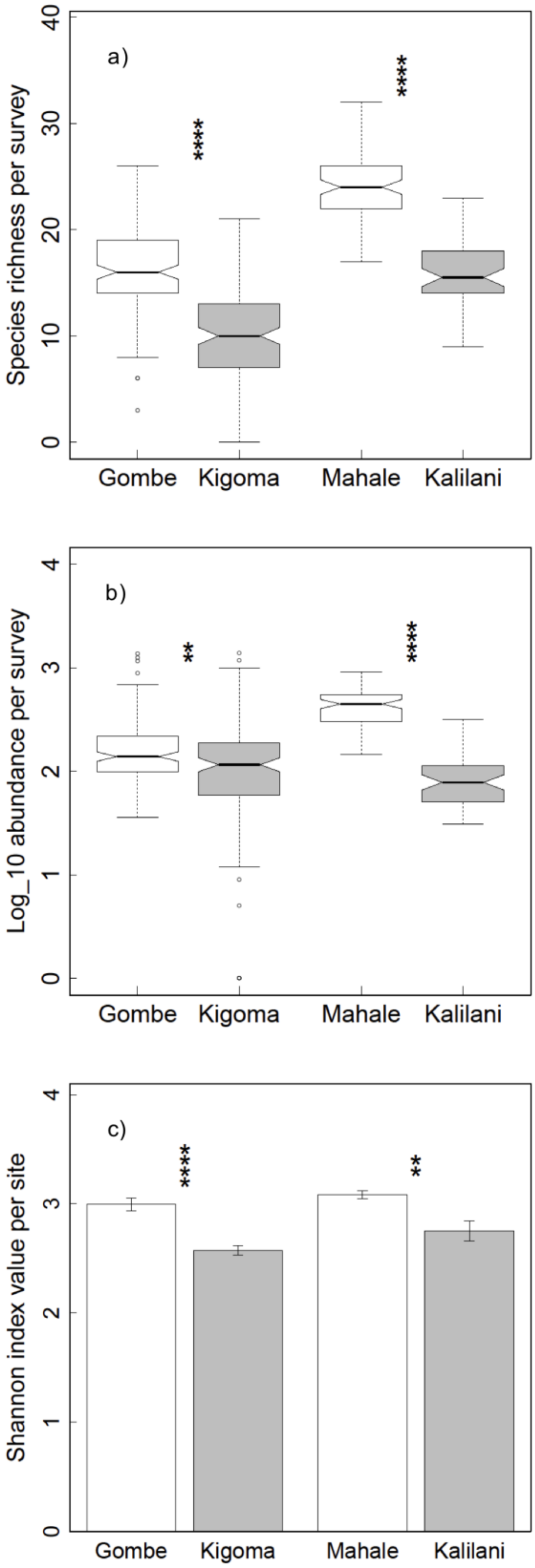

Figure S2. Pairwise comparisons of alpha diversity values between protected areas (white) and unprotected (grey), for (a) Species richness per survey, (b) Abundance per survey and (c) Shannon index per site. Asterisks indicate a significant difference (** $P \leq 0.01$, **** $P \leq 0.0001$) between site pairs using a Mann Whitney Wilcoxon test (species richness and abundance), and a Hutcheson's t-test (Shannon index).

Table S6. The correlations between relative HD rank and alpha and beta diversity for cichlids where all sites are standardised to 42 surveys and under 4km shoreline distance. Rho and p values are given for Spearman's Rank Correlation of alpha and beta diversity values. Asterisks indicate a significant positive or negative correlation (* $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$, **** $P \leq 0.0001$)

	ALPHA DIVERSITY					*BETA DIVERSITY*			
	Relative human disturbance rank	**Median species richness per survey**	**Median log abundance per survey (all species pooled)**	**Pielou's evenness index per site**	**Effective number of species per site**	**Sørensen dissimilarity value within site**	**Sørensen loss component (%)**	**Bray-Curtis dissimilarity value within site**	**Bray-Curtis loss component (%)**
Kigoma Town	7	10	2.2	0.57	8	0.48	25	0.72	38
Kigoma Deforested	6	12.6	2.3	0.55	7.9	0.53	23	0.76	27
Jakobsen's Beach	5	15.0	2.3	0.55	7.7	0.49	18	0.63	33
Kalilani Village	4	15	1.9	0.73	14.8	0.48	17	0.7	21
Gombe NP	3	17	2.2	0.71	14.8	0.38	24	0.63	32
Mahale S1	1.5	24	2.6	0.70	17.8	0.40	13	0.64	20
Mahale S2	1.5	21	2.6	0.67	15.2	0.45	11	0.73	15
Rho value		**-0.982**	-0.519	-0.545	**-0.836**	0.727	**0.775**	0.236	**0.811**
***P* value**		<0.001****	0.233	0.205	0.019*	0.064	0.041*	0.610	0.027*

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