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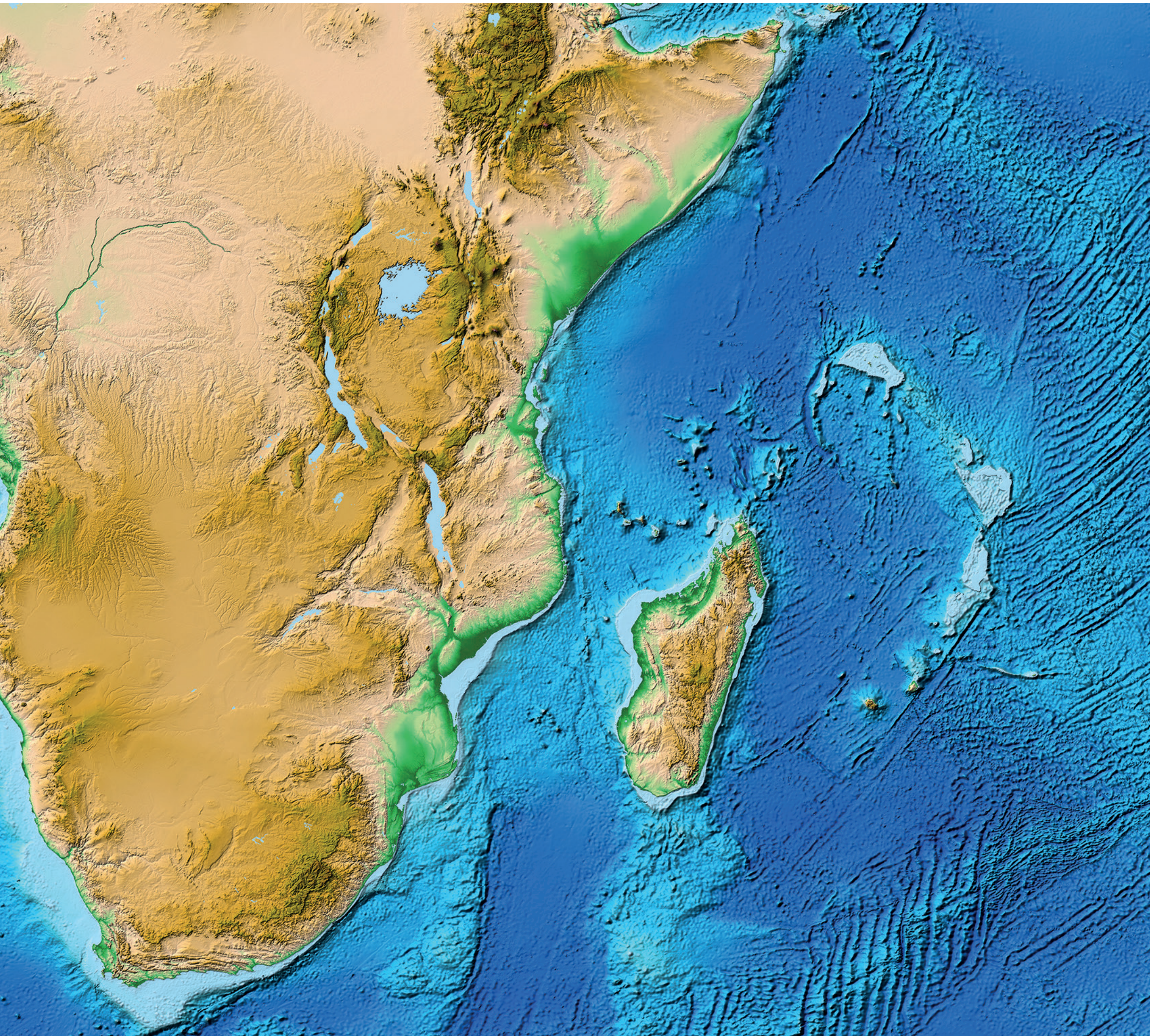

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Cover image: Relief model of the WIO surface that integrates land topography and ocean bathymetry. Amante and Eakins / National Geophysical Data Center, NOAA (2009)

Gear-based species selectivity and potential interactions between artisanal and aquarium fisheries in coastal Kenya: implications for reef fisheries management

*Gladys M. Okemwa[1, 2], Boaz Kaunda-Arara[2], Edward N. Kimani[1], Benrick Ogutu[3], Harrison Ong'anda[1], Clay Obota[1], Mary Ontomwa[1]

[1] Kenya Marine and Fisheries Research Institute, P.O. Box 81651-80100, Mombasa, Kenya

[2] University of Eldoret, P.O. Box 1125-30100, Eldoret, Kenya

[3] State Department of Fisheries, P.O. Box 90423-80100, Mombasa, Kenya

* Corresponding author: gokemwa@kmfri.co.ke

Abstract
Multivariate and ecological approaches were used to investigate potential interactions in species selectivity between artisanal and aquarium fisheries on the south coast of Kenya. Aquarium fishery landings were monitored from September 2010 to March 2013, while artisanal landings were monitored over 1 year from January to December 2014. Target aquarium species constituted approximately 12% of the artisanal catches by weight and 8% by relative abundance, and was comprised of 17 fish families and 58 species dominated by wrasses. Handlines and spearguns had the highest potential interaction with the aquarium fishery. Pair-wise comparisons of Pianka's overlap index revealed basket traps and monofilament gillnets as having the strongest overlap. The index further showed that aquarium snorkel fishers had a higher overlap in species selectivity with artisanal gears; while DCA ordination also showed a high overlap in the shared fishing grounds. DCA ordination further revealed the ornamental angelfishes, *Pomacanthus imperata* and *Pomacanthus semicirculatus* as strongly associated with spearguns, while the wrasses *Halichoeres hortulanus* and *Thalassoma hebraicum*, and the surgeonfish *Acanthurus leucosternon* were strongly associated with handlines. Spatial regulation of fishing effort will be most appropriate in minimizing the cumulative effects of fishing on vulnerable species resulting from interactions between the two fisheries.

Keywords: catch composition, resource overlap, Shimoni, Western Indian Ocean

Introduction
Coral reef fisheries are multi-species and multi-gear in nature, and provide an important source of protein as well as livelihoods for coastal communities worldwide (Davies *et al*., 2009). Over 55% of the world's coral reefs have been estimated to be under threat from unsustainable fishing practices caused by unregulated fishing effort and the use of destructive fishing methods (Jennings and Keiser, 1998; Burke *et al.,* 2011) including beach seines (Mangi and Roberts, 2006) and dynamite fishing (Wells, 2009). Nearly 95% of Southeast Asian reefs are affected by overfishing compared to 65% of reefs in the Indian Ocean (Burke *et al*., 2011). In Kenya, an estimated 163 reef fish species belonging to 38 families are captured in artisanal food fisheries (McClanahan and Mangi, 2004; Tuda *et al*., 2016), while the aquarium fishery targets over 220 reef fish species and continues to expand in the diversity of species targeted and extent of fishing grounds (Okemwa *et al*., 2016). Artisanal fishers mainly use passive non-selective fishing methods such as basket traps, gillnets and handlines, but even methods which may seem to be selective such as spearguns also capture fish opportunistically and are thus non-selective in practice (Fenner, 2012). Artisanal gears also capture a high volume of juvenile reef fish with estimates averaging at about 50% of the total catches (Mangi and Roberts, 2006). On the other hand, aquarium fishers selectively target juveniles of specific species and sizes which are strongly associated with corals (Wood, 2001; Sadovy and Vincent, 2002).

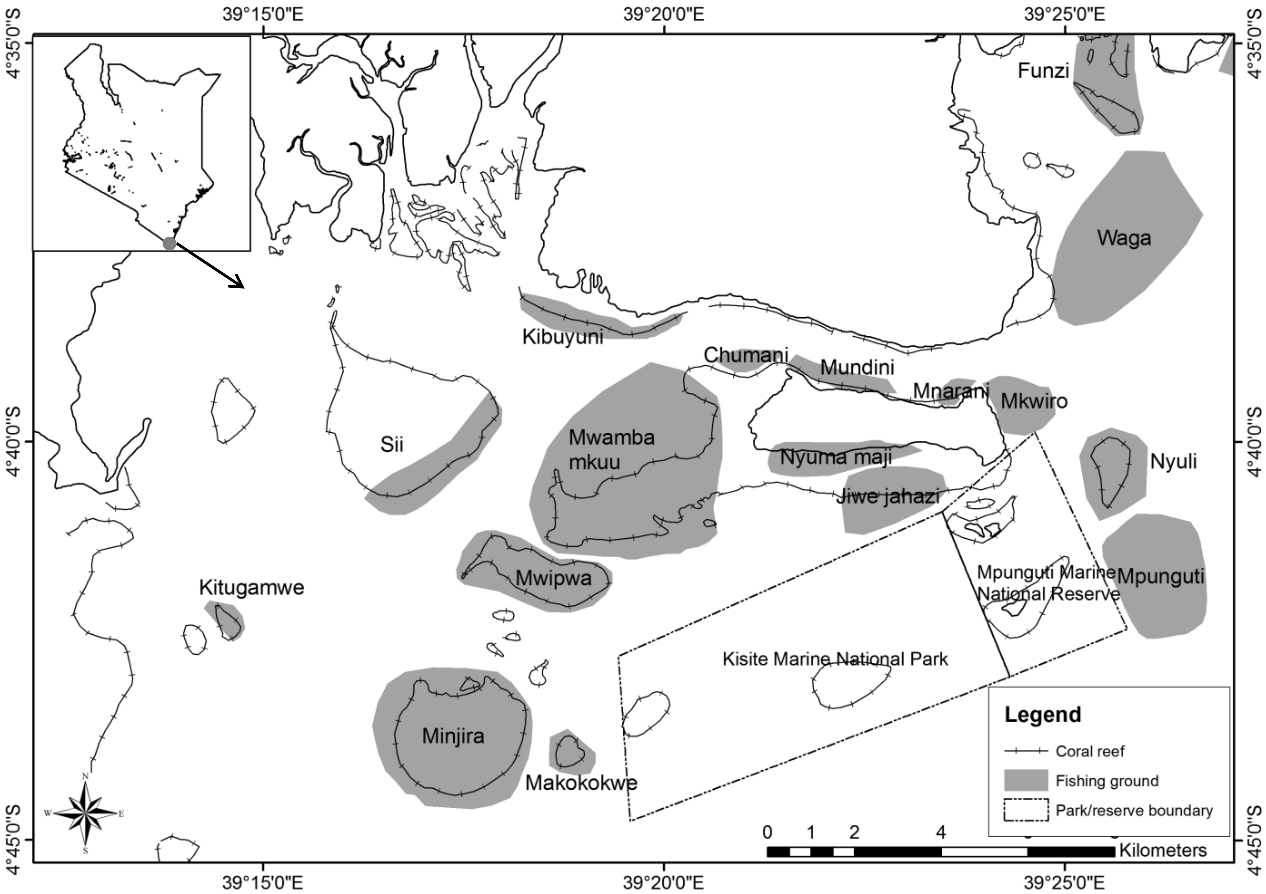

Figure 1. Map showing the location of key artisanal and aquarium fishing grounds in the Shimoni area of coastal Kenya.

Management of multi-species and multi-gear reef fisheries is typically challenging and requires a good understanding of the technical interactions, whether direct or sequential, between co-occurring fishing gears and fisheries (Hoggarth *et al.*, 2006). Such interactions can have significant impacts on fisheries yields, biodiversity and habitat quality especially where fishing effort is concentrated within restricted areas. In shared fishing grounds, different gear types and fishing methods can interact resulting in different life stages of the same stocks suffering fishing mortalities due to variations in the selectivity of the fishing methods used. Various studies have assessed interactions in species selectivity among artisanal gears (McClanahan and Mangi, 2004; Nunes *et al.*, 2009; Stergio *et al.*, 2002; Tuda *et al.*, 2016), between artisanal and industrial fisheries (e.g. Leroy *et al.*, 2016; Munga *et al.*, 2014), and between recreational and commercial fisheries (Cooke and Cowxs, 2006). However, similar studies within small spatial-scales are limited, especially in the western Indian Ocean (WIO). Regular collection of site-specific information on fishing pressure, gear use and selectivity can be useful in assisting managers to make informed decisions about adaptively managing gear (Cinner *et al.*, 2012). In this context, this study aimed to investigate potential interactions in species selectivity between artisanal fishing gears and commercial aquarium fisheries in coastal Kenya and further discusses the implications for reef fisheries management.

Materials and Methods

Study area

The study was carried out on the south coast of Kenya in the Shimoni area near the Tanzanian border (Fig. 1). The Shimoni area is fringed with an extensive cover of mangrove forests, and contains intertidal areas covered with seagrass beds and a complex of patchy and submerged lagoonal reefs. Water depth in the fishing grounds varies but is generally shallow (up to 12 metres) during spring low tide. The area contains the Kisite Marine National Park (KMNP) (Fig. 1), a no-take zone where all fishing activities are prohibited, and the Mpunguti Marine National Reserve (MMNR) which serves as a buffer zone adjacent to KMNP where the use of traditional fishing methods such as basket traps

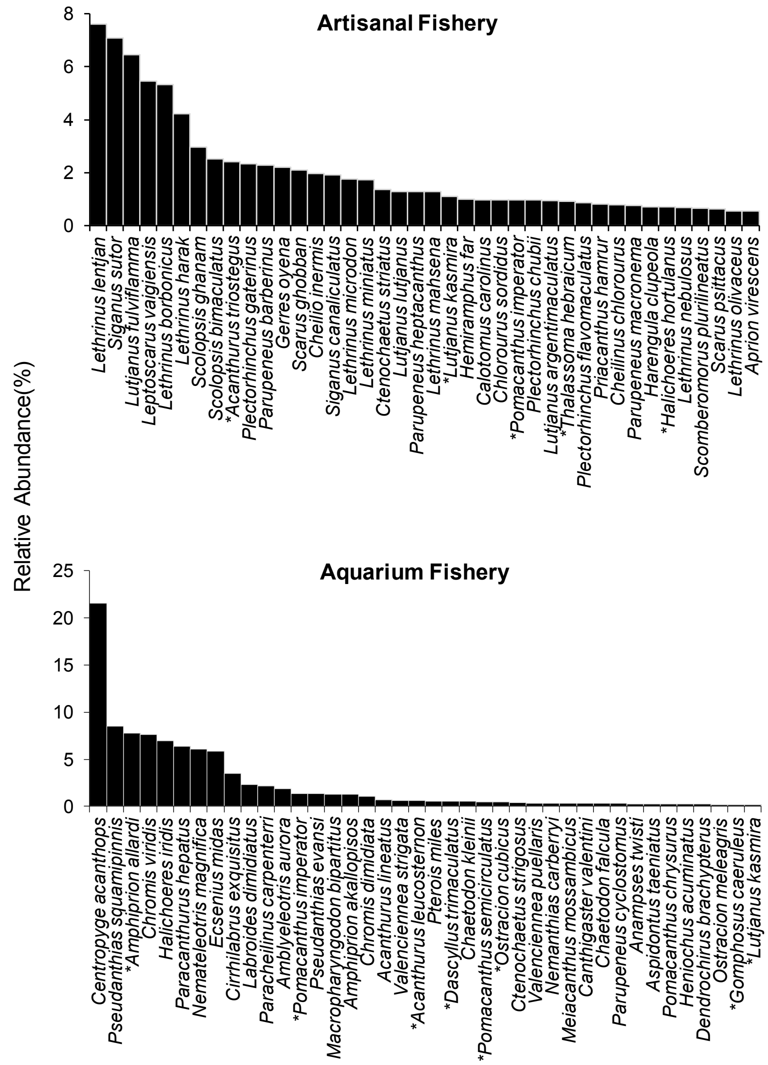

Figure 2. Composition of the 40 most abundant reef fish species landed by (a) artisanal and (b) aquarium fisheries in the Shimoni area, Kenya. Species that overlapped between the two fisheries are marked with an asterisk.

and handlines is allowed. Artisanal fishers mainly use traditional non-motorized vessels which limits fishing effort to nearshore shallow areas within coral reefs, mangrove creeks, and seagrass beds (McClanahan and Mangi, 2000). Shimoni is also notably among the most important fishing grounds for the marine aquarium fishery in Kenya (Okemwa *et al*., 2016). Aquarium fishers use scoop and barrier nets by either snorkel or SCUBA diving and fish in small distinct groups targeting different species influenced by depth distributions (Okemwa *et al*., 2016). Generally, fishing activities in the area are influenced by monsoon seasonality with more intense fishing effort being exerted during the northeast monsoon season (NEM) when the sea is calm (Ochiewo, 2004).

Data collection

Artisanal fisher catches were monitored for 5 - 7 days monthly from January to December 2014. The landings were sampled randomly as fishers landed the catches for weighing. For each fishing operation, the fishing gear used, boat type, fishing grounds, and number of fishers was recorded. The total weight (kg) of the entire catch for each fisher was measured and recorded. The catch was then sorted and the landed fish identified to species using identification guides (Lieske and Myers, 2001; Anam and Mostarda, 2012). Digital photos were taken for fish that were not immediately identifiable and a photo identification number was recorded as a reference for later identification purposes. The individual weight of the fish was measured using a hand-held electronic spring

Table 1. The number of species (S), Margalef's species richness (d), Shannon diversity index (*H'*) and Pielou's evenness (*J'*) for the artisanal and aquarium fishery in Shimoni, Kenya by gear type and fishing method (SCUBA fishing vs. snorkeling)

Fishery	Gears / Methods	Average length of fish (cm)	S	(D)	(*J'*)	(*H'*)	Avg. nº of species day $^{-1}$ vessel $^{-1}$
Artisanal fishery	Handlines	22	145	18.37	0.73	3.62	13
	Basket traps	20	104	13.81	0.70	3.25	11
	Spearguns	23	88	12.78	0.68	3.07	8
	Monofilament nets	23	45	8.10	0.77	2.93	18
	Reef seines	20	47	7.04	0.68	2.60	6
	Gillnets	27	38	6.20	0.71	2.59	4
	Cast nets	11	3	0.31	0.46	0.51	2
	Ringnets	58	2	0.25	0.94	0.65	1
Aquarium fishery	SCUBA fishing	-	106	10.65	0.58	2.71	8
	Snorkeling	-	122	12.4	0.55	2.67	10

balance (to the nearest gram), while total length (TL) was taken using a measuring board to the nearest 0.1 cm. In cases where the catches were large (e.g. schooling fish), a representative sample of approximately 10-20 % of the total catch was taken and measured as above.

For the aquarium fishery, the fish catch data was collected for 5-10 days monthly from September 2010 to March 2013. Vessel captains were requested to record the species and numbers collected, total number of fishers and fishing method used, and the fishing grounds visited for each fishing trip. The data recorded by the captains was validated on landing before the fish were loaded into vehicles for transportation to holding facilities. In addition, secondary data officially reported by aquarium dealers was obtained from the State Department of Fisheries (SDF) for the period January - December 2014 detailing species and numbers collected from the Shimoni area.

Data analysis

Artisanal fishing effort was estimated as the summation of number of fishers recorded daily (number of fisher days) for each gear type. The fish species landed were categorized by commercial use as: C (artisanal commercial) or A (Aquarium). Categorization of aquarium species was based on published species lists (Okemwa *et al.*, 2016) and data compiled by the SDF. To estimate the proportion of juvenile fish caught by each gear, the total lengths for each species caught were compared against published estimates of length at 50% maturity extracted from Fishbase (Froese and Pauly, 2015) and published literature (Mangi and Roberts, 2006). The fish were then categorized as either juvenile or mature and the relative percent abundance of juveniles for each gear calculated.

Histograms were generated for the 40 most abundant species for the main gear types in order to compare catch composition between gear types within a fishery, and between fisheries (Artisanal and Aquarium).

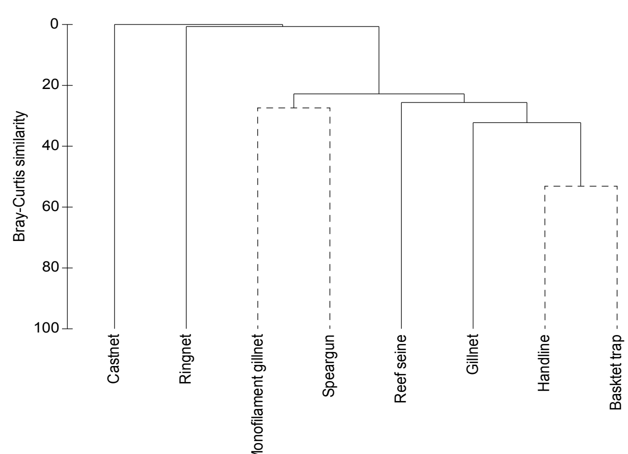

Figure 3. Cluster analysis dendrogram showing the similarity in species composition of 8 gear types used in the Shimoni area, Kenya. The dashed lines indicate sub-clusters that were not detected as significant by the similarity profile (SIMPROF) test (at P<0.5).

Table 2. A pairwise matrix showing interactions in species selectivity among the main artisanal fishing gear types and aquarium fishing methods in Shimoni, Kenya, based on Pianka's niche overlap (*Oi*) index which ranges between 0 (total separation) and 1 (total overlap)

	Handline	Basket trap	Speargun	Reefseine	Gillnet	Mono-filament gillnet	Aquarium SCUBA fishing	Aquarium snorkel fishing
Handline		0.545	0.233	0.392	0.453	0.334	0.002	0.039
Basket trap			0.415	0.469	0.549	0.722	0.0001	0.005
Speargun				0.326	0.176	0.418	0.012	0.017
Reef seine					0.368	0.351	0.001	0.009
Gillnet						0.403	0.0001	0.002
Monofilament gillnet							0.0003	0.003
Aquarium SCUBA fishing								0.016

Three community indices (species richness *S*, Shannon-Wiener *H'* and Pielou's evenness *J'*) as described by Magurran (1988) were used to characterize the diversity of the catches. Hierarchical agglomerative cluster analysis (Clarke and Warwick, 2001) was used to confirm the degree of similarity in species selectivity among the artisanal gear types. Prior to the cluster analysis, Bray-Curtis similarity index was applied on square-root transformed data to down-weigh the influence of rare and extremely abundant species. The Similarity Profile (SIMPROF) analysis test (Clarke *et al*., 2008) was then used to detect the presence of a statistically significant structure in identified clusters. Further, Pianka's index (Pianka, 1973) was used to characterize overlap in species selectivity, calculated as follows:

$$O_{kl} = = \frac{\sum_i^n p_{il} p_{ik}}{\sqrt{\sum_i^n p_{il}^2 \sum_i^n p_{ik}^2}}$$

Where, O_{kl} = Pianka's index of niche overlap between gear k and gear l, p_{il} = the proportion of the *i*th species in gear *l*, p_{ik} = the proportion of the *i*th species in gear *k*, and n = the total number of species. The index ranges from 0 (no species in common) to 1 (complete overlap). There was a basic assumption in using the index that all species were equally accessible to all the gears. Detrended Correspondence Analysis (DCA, Hill and Gauch, 1980), which ordinates associations between paired groups in a two-dimensional space, was applied to test for associations in species selectivity among artisanal fishing gears based on the composition of aquarium species captured, and for associations with fishing grounds. In addition, the dominance of aquarium species captured in the artisanal gears was assessed by plotting *K*-Dominance Curves (Clarke and Warwick, 2001) of the catches for the main gear types. The data analyses were done using PRIMER version 6.1.5 (Clarke and Gorley, 2006) and STATISTICA version 7 Software (StatSoft, Inc., 2007). EcoSim v. 7.0 (Gotelli and Entsminger, 2001) was used to calculate niche overlaps.

Results

Species composition

A total of 7,786 individuals caught in the artisanal gears were identified to species and consisted of 52 families and 230 species. The artisanal catch was dominated by Lethrinidae (20%), Atherinidae (10.3%), Siganidae (9%), Scaridae (9%), Lutjanidae (8.2%) and Labridae (6%) by weight. The most abundant species included *Lethrinus lentjan* (7.6%), *Siganus sutor* (7.1%), *Lutjanus fulviflamma* (6.5%), *Leptoscarus vaigiensis* (5.5%), *Lethrinus borbonius* (5.3%) and *Lethrinus harak* (4.2%) respectively (Fig. 2a). For the aquarium fishery, a total of 2,033 fish were recorded constituting 183 species of which 90% was composed of 23 species (Fig. 2b). Aquarium fisher catches were dominated by small sized species including the angelfish *Centropyge acanthops* (21%) and the anthias, *Pseudanthias squamippinnis* (9%).

Gear use and selectivity

Artisanal fishers mainly used handlines, spearguns, basket traps, reef seines and gillnets which constituted 89% of total landed catch by weight (2795 kg),

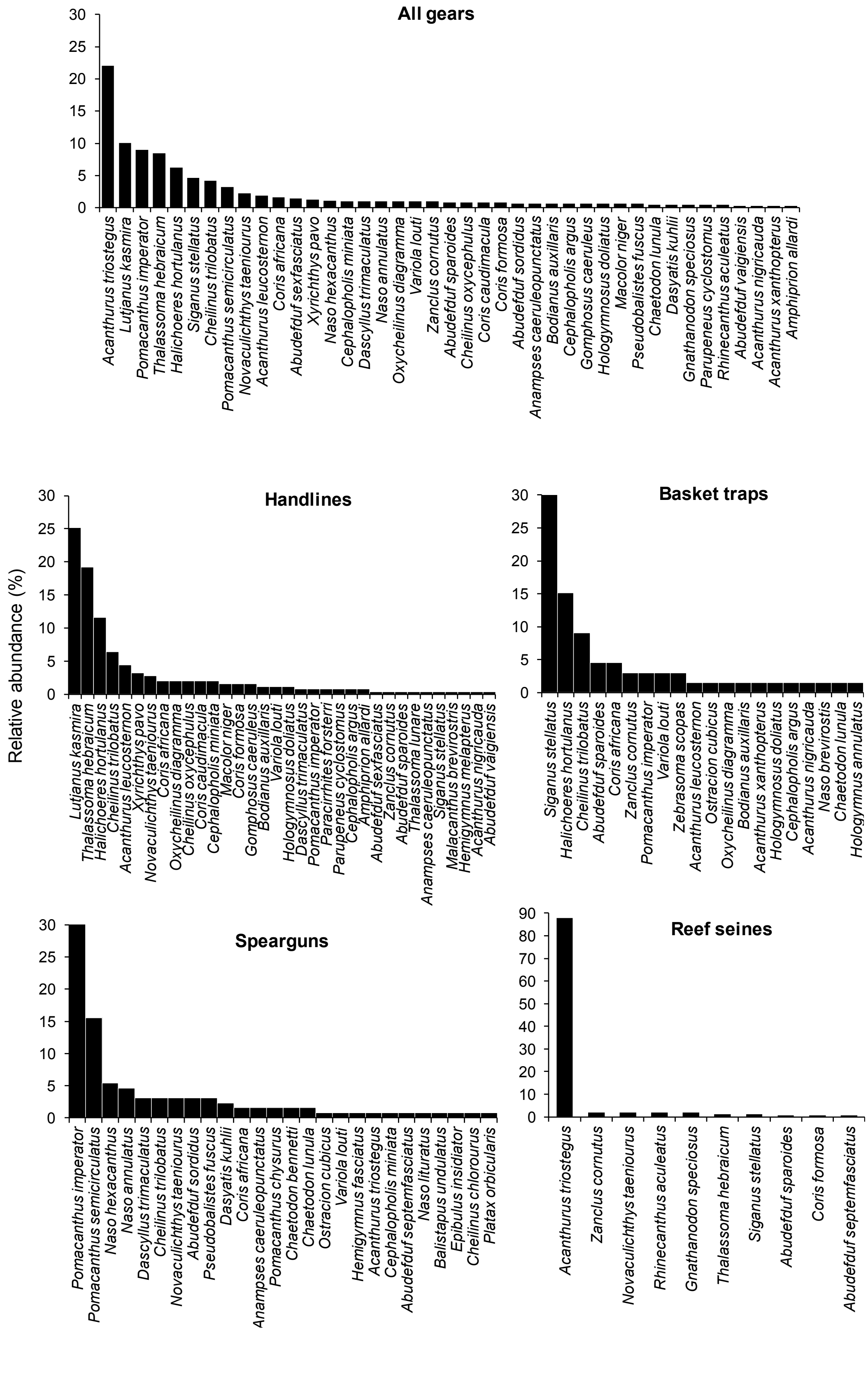

Figure 4. The relative abundance of aquarium species captured by the four main artisanal gear types used in the Shimoni area, Kenya.

Table 3. The diversity of aquarium species captured by artisanal fishers from major fishing grounds in the Shimoni area, Kenya indicating number of species, S; number of fishing units sampled, N, and proportional abundance; Margalef's species richness D; Pielou's evenness, *J'*; and Shannon diversity index, *H'*; during January to December 2014. Refer to Fig. 1 for locations.

Fishing grounds	S	N	Proportional abundance (%)	D	*J'*	*H'*
Mpunguti	39	194	30.1	7.21	0.80	2.92
Mkwiro	17	170	26.4	3.12	0.34	0.96
Kitugamwe	11	73	11.3	2.33	0.70	1.68
Nyuli	20	72	11.2	4.44	0.86	2.58
Waga	19	47	7.3	4.68	0.87	2.55
Mwamba mkuu	15	43	6.7	3.72	0.83	2.25
Mwipwa	7	12	1.9	2.42	0.96	1.86
Sii Island	2	3	0.5	0.91	0.92	0.64
Mijira	1	2	0.3	-	-	-
Mnarani	2	9	1.4	0.46	0.50	0.35
Kibuyuni	5	7	1.1	2.06	0.96	1.55
Nyuma ya maji	5	9	1.4	1.82	0.89	1.43
Jiwe jahazi	3	4	0.6	1.44	0.95	1.04

and 95% of the total fishing effort (n = 4367 fisher days). Handline fishers contributed the highest fishing effort (1 265 fisher days, 29%) followed by speargun fishers (1 040 fisher days, 24%) and basket trap fishers (1 015 fisher days, 23%). However, by weight, basket trap fishers contributed the highest catches (743 kg, 27%), followed by speargun (655 kg, 23%) and handline fishers (622 kg, 22%). Handline fishers cumulatively captured the highest number of species (n = 145), the highest average number of species per day (13 species) and the highest diversity of species (*H'* = 3.62). This was followed by basket traps (104 species, 11 species/day, *H'= 3.25*) and spearguns (88 species, 8 species/day, *H'=3.07*); while cast nets and ringnets had the lowest (Table 1). On average, the Pielou's evenness (*J'*) index was about 0.71, with ringnets having the highest (*J'* = 0.94) and cast nets having the lowest (*J'* = 0.46) (Table 1). In comparison, a total of 153 aquarium fish species (*H'* = 3.33) were collected from Shimoni during January to December 2014 based on officially reported statistics. The catch monitoring done between September 2010 and March 2013 showed that aquarium snorkel fishers collected more species compared to SCUBA fishers, however the species diversity between the two fishing methods was relatively similar (Table 1).

Cluster analysis of the main artisanal gear types used, based on the species composition of the catches, revealed 3 distinct clusters at 20% similarity (Fig. 3). The first cluster (cluster 1) was characterized by basket traps, handlines, gillnets, speargun, monofilament gillnets and reef seines. The second cluster was characterized by castnets, and the third cluster by ringnets. Within cluster 1, the SIMPROF test further revealed no significant ($p < 0.05$) statistical evidence of a sub-structure for the grouping of handlines with basket traps, and speargun with monofilament gillnets. Pair-wise comparisons using Pianka's niche overlap index for the gears grouped in cluster 1 showed that basket traps and monofilament gillnets had the strongest overlap in species selectivity (*O* = 0.722) followed by basket traps and gillnets (*O* = 0.549) and basket traps and handlines (*O* = 0.545), while the lowest niche overlap was between speargun and gillnets (*O* = 0.176) (Table 2).

Potential interactions between aquarium and artisanal fisheries

A total of 660 (8%) fish categorized as aquarium species were recorded from the sampled artisanal catches. The fish constituted of 58 species and 17 families (see Appendix 1) of which 80% were adult sized individuals. Labridae dominated the catches constituting 31% by relative abundance and 19 species, followed by

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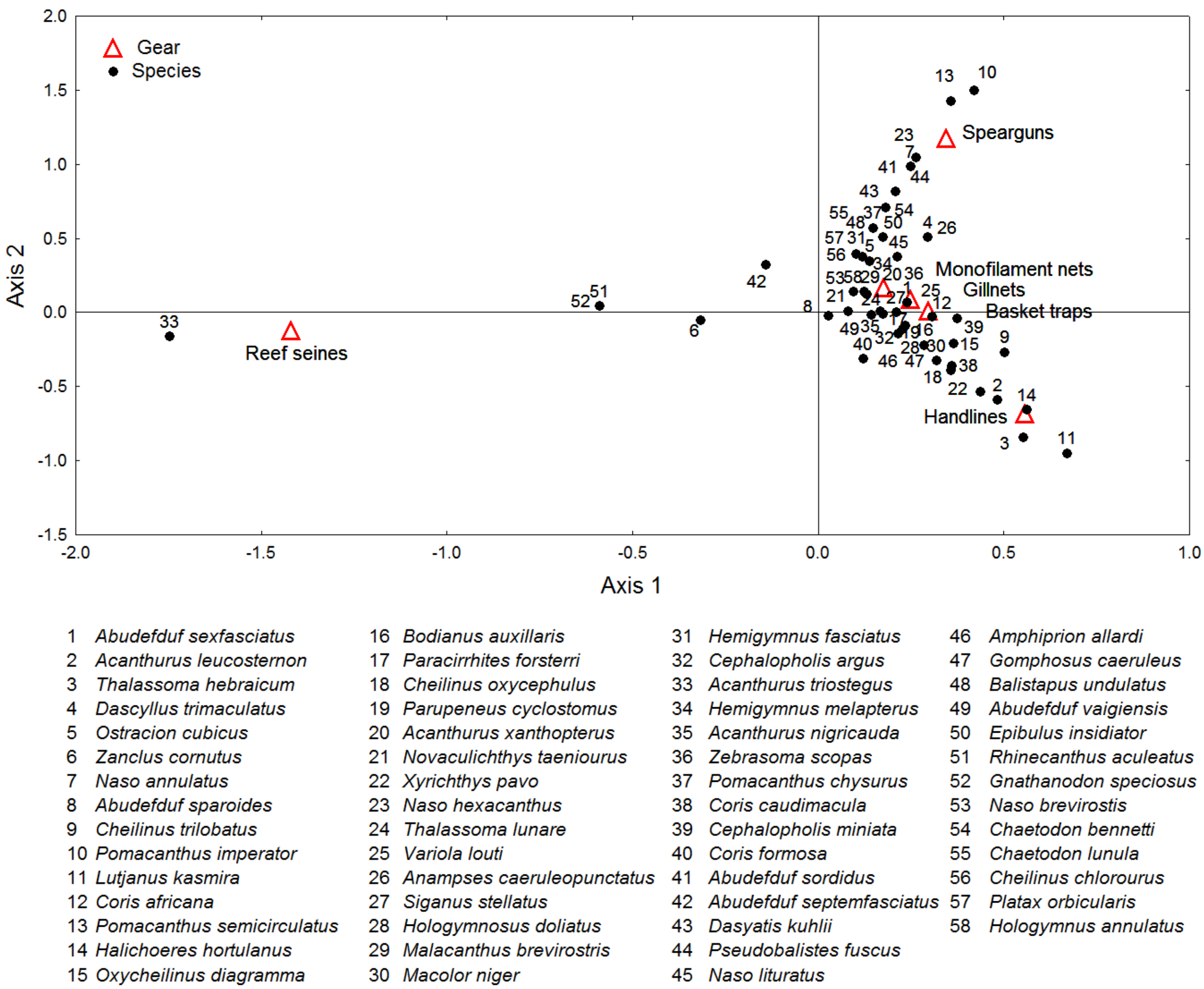

Figure 5. Results of Detrended Correspondence Analysis (DCA) of artisanal fishery catches indicating similarity in the composition of aquarium species captured by the main key gear types used in the Shimoni area, Kenya.

Acanthuridae (28%, 9 species), Pomacanthidae (12%, 3 species), Lutjanidae (11%, 2 species), and Pomacentridae (5%, 7 species). Handlines, basket traps, spearguns and reef seines interacted most in species selectivity with the aquarium fishery (Fig. 4). Pairwise comparison of Pianka's niche overlap between the artisanal gears and the aquarium fishing methods (SCUBA vs snorkeling) showed that handlines and spearguns had the highest overlap with the aquarium fishery respectively, and more so with snorkel fishers (Table 2). The most abundant aquarium species captured included *Acanthurus triostegus* (reef seines), *Lutjanus kasmira* (handlines), *Pomacanthus imperator* (spearguns) and *Thalassoma hebraicum* (handlines and reef seines) (Fig. 4).

The DCA ordination showed the angelfishes, *Pomacanthus imperata* and *Pomacanthus semicirculatus* as strongly associated with spearguns, while the wrasses *Halichoeres hortulanus* and *Thalassoma hebraicum*, and the surgeonfish, *Acanthurus leucosternon* were strongly associated with handlines in the artisanal fisheries (Fig. 5). DCA ordination further showed that the composition of aquarium species in reef seine catches was distinctly different from all the other gear types. Although the other gear types generally grouped together, handlines remained distinctly separated from spearguns; while gillnets, monofilament gillnets and basket traps grouped together indicating high overlaps in the selectivity for aquarium species among the three gears.

Results of the *K*-dominance curves showed a high dominance of aquarium species captured in reef seines, gillnets and monofilament gillnets, likely due to the capture of schooling surgeonfishes *Acanthurus triostegus* and the snapper, *Lutjanus kasmira* (Fig. 6a).

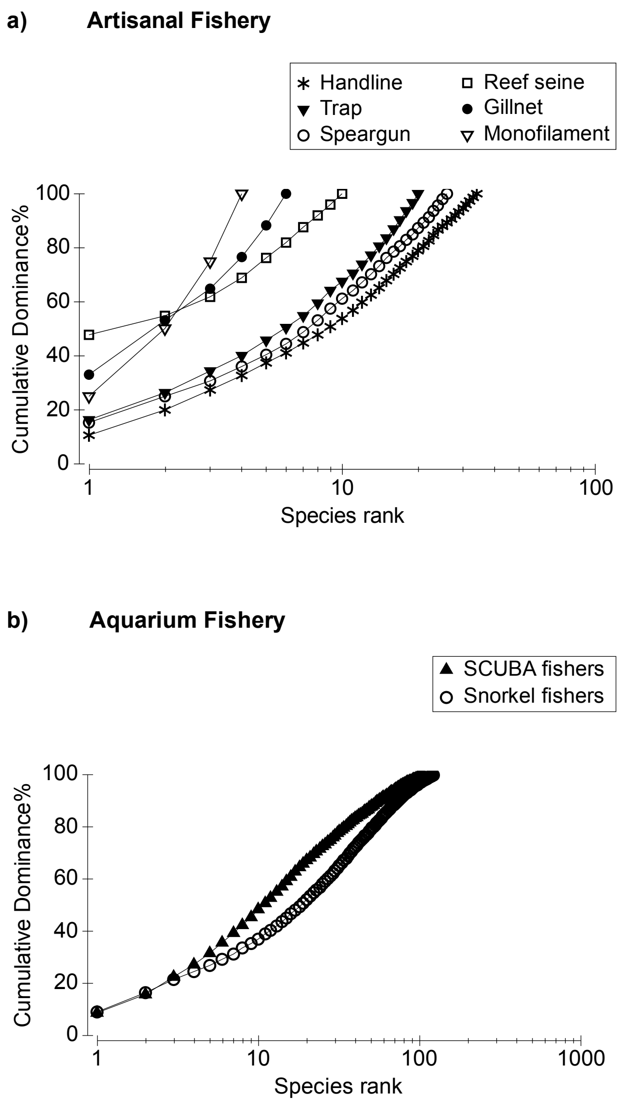

Figure 6. *K*-Dominance curves of (a) artisanal fishing gears based on the composition of aquarium species captured and (b) aquarium fishing methods in the Shimoni area, Kenya.

Dominance was also higher for aquarium SCUBA fishers compared to snorkel fishers (Fig. 6b).

On a spatial scale, 93% of the aquarium fish were captured from 6 fishing grounds: Mpunguti, Mkwiro, Kitugamwe, Nyuli, Waga and Mwamba mkuu (Table 3, see Fig. 1 for locations). The highest diversity of aquarium species was captured from the Mpunguti area while the lowest was from Mnarani. DCA ordination associated handlines, basket traps, and speargun with the Mpunguti area (including the adjacent reserve), Mkwiro, Waga, Jiwe jahazi and Kibuyuni (Fig. 7), while reef seines and cast nets were mainly associated with Mwamba mkuu, Sii Island and Chumani fishing grounds. The DCA also associated aquarium snorkel fishers with more diverse fishing grounds compared to SCUBA fishers who mainly concentrated their fishing effort in Nyuli (Fig. 7). Aquarium snorkel fishers are thus more likely to have technical interactions with artisanal fishing gears both in terms of species selectivity as well as spatially in the sharing of fishing grounds.

Discussion and Conclusion

This is the first study in the WIO region to examine interactions between artisanal fishing gears and the aquarium fishery. A limitation of the study was the time lag in the sampling periods as gear selectivity can vary depending on the fishing effort, fishing time, season and even the area fished (Azovsky, 2011). Nonetheless, the study provides strong evidence of potential interactions between the two fisheries. A major finding of the study was that handlines, basket traps and speargun had the highest potential to interact with the aquarium fishery. The study estimated that approximately 8% of the artisanal catch by abundance consisted of species of value to the aquarium fishery. In comparison, Cinner *et al.* (2009) estimated that <6% of artisanal fish catches by abundance constituted species that were strongly associated with corals, many of which are most likely targeted by aquarium fishers. Artisanal fishers preferentially target the largest sized individuals and there was evidence that large sized adults of the angelfishes *Pomacanthus imperator* and *Pomacanthus semicirculatus* were selectively targeted by speargun fishers. Selective targeting of angelfishes by speargun fishers has also been observed elsewhere in Belize (Babcock *et al.,* 2013) and is an issue of concern as these species are highly valued, heavily fished and highly vulnerable to localized population declines due to their life history (Okemwa *et al.*, 2016). Further research is needed to assess how such selective fishing practices affect recruitment dynamics of affected populations in the area.

The study showed that certain fishing grounds were preferred by both fisheries. Aquarium snorkel fishers were observed to be more likely to interact with artisanal fishing gears compared to SCUBA fishers both in terms of species selectivity as well as the diversity of shared fishing grounds. Various studies have demonstrated that allocation of fishing effort is essentially not random as fishers will tend to concentrate in areas where they are likely to experience higher catch rates to maximize on returns (Johannes *et al.*, 2001; Pet-Soede *et al.,* 2001; Wiyono *et al.*, 2006; Daw, 2008). As observed by Micheli *et al.* (2014), multiple fisheries are more likely to cause local depletion of fish stocks

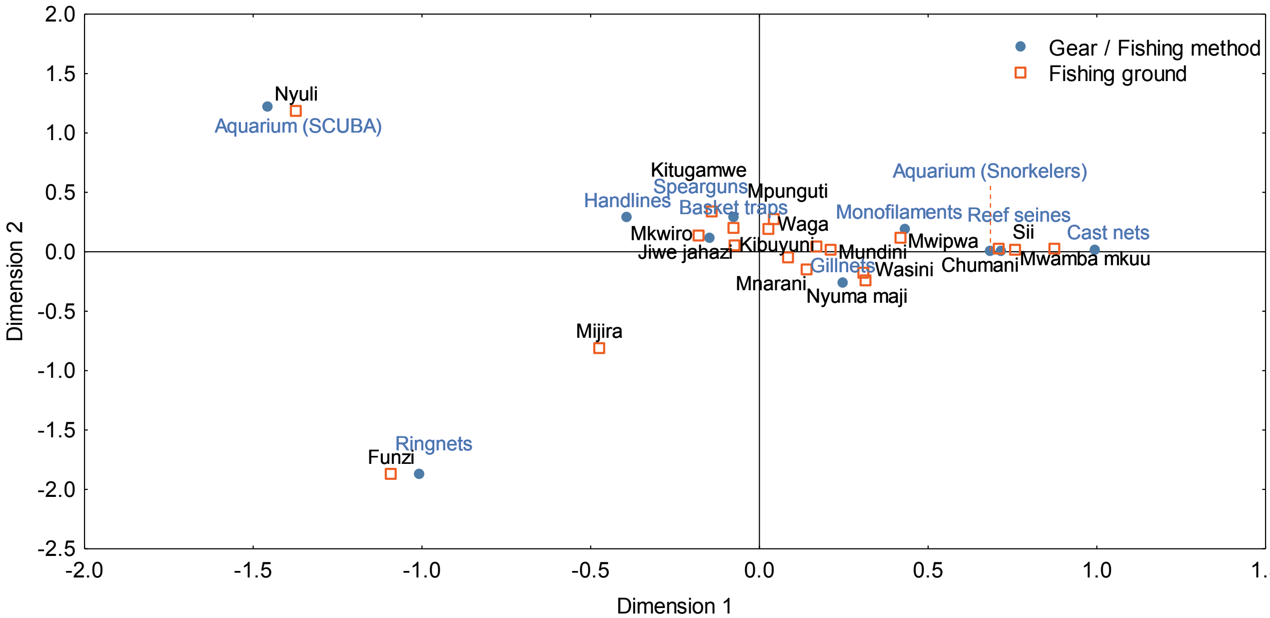

Figure 7. Detrended correspondence analysis plot showing the spatial association of artisanal gear types and aquarium fishing methods with fishing grounds in the Shimoni area, Kenya.

compared to individual fisheries. Thus, local scale ecosystem based management interventions such as spatial closures are likely to be the most effective in sustaining the affected fish populations. The Kisite Marine National Park provides an important replenishment zone for the study area. This is further complemented by a number of Community Conservation Areas (CCAs) which have increasingly gained local support by resource managers and fisher communities (Rockliffe *et al.*, 2014). However, the existing spatial controls need to be further augmented with gear-based interventions including improved enforcement of the ban on speargun and adoption of modified gears that are more selective in minimizing the capture of juveniles and low-value food species. Trials on basket traps modified with escape gaps have yielded promising results in Kenya (see Mbaru and McClanahan, 2013; Gomes *et al.*, 2014); however, similar trials to establish optimum mesh and hook sizes for gillnets and handlines are also recommended. In conclusion, an important consideration for fisheries managers will be to closely monitor fishery interactions at small spatial scales as demonstrated in this study to assist in developing effective strategies so as to minimize the cumulative impacts from both fisheries on vulnerable species that may be at risk of depletion.

Acknowledgements

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Appendix 1. The full list of 58 species that overlapped between the artisanal and aquarium fishery in Shimoni area during January to December 2014, categorized by the gear type and commercial use (C: artisanal commercial vs A: Aquarium)

Family	Scientific Name	Handline	Reefseine	Gillnet	Basket traps	Mono-filament	Speargun	Value Use
Pomacentridae	*Abudefduf sexfasciatus*	x		x				A
	Abudefduf sordidus						x	A
	Abudefduf sparoides	x	x		x			A
	Abudefduf vaigiensis	x		x				A
	Amphiprion allardi	x						A
	Dascyllus trimaculatus	x					x	A
Acanthuridae	*Acanthurus leucosternon*	x			x			A
	Acanthurus triostegus		x			x	x	C/A
	Acanthurus xanthopterus			x	x			C/A
	Naso annulatus						x	C/A
	Naso brachycentron		x					C/A
	Naso brevirostis				x			C/A
	Naso hexacanthus						x	C/A
	Naso lituratus						x	C/A
	Naso vlamingi		x					C/A
	Zebrasoma scopas				x			A
Carangidae	*Gnathanodon speciosus*		x				x	C/A
Chaetodontidae	*Chaetodon bennetti*						x	A
	Chaetodon lineolatus	x						A
	Chaetodon lunula				x		x	A
	Chaetodon trifasciatus					x		A

Labridae	*Anampses caeruleopunctatus*		x				x	x	C/A
	Bodianus auxillaris		x			x			A
	Cheilinus chlorourus		x			x	x	x	C/A
	Cheilinus trilobatus		x			x		x	C/A
	Coris africana		x			x		x	C/A
	Coris caudimacula		x						C/A
	Coris formosa		x	x					C/A
	Epibulus insidiator							x	C/A
	Halichoeres hortulanus		x			x			C/A
	Halichoeres scapularis		x						C/A
	Hemigymnus fasciatus						x	x	C/A
	Hologymnosus doliatus		x			x			C/A
	Hologymnus annulatus				x				C/A
	Labroides dimidiatus	x							A
	Novaculichthys taeniourus	x	x				x		A
	Thalassoma hebraicum	x	x	x					C/A
	Thalassoma lunare	x							C/A
	Xyrichthys pavo	x							C/A
Ostraciidae	*Ostracion cubicus*				x		x		A
Cirrhitidae	*Paracirrhites forsterri*	x							A
Zanclidae	*Zanclus cornutus*	x	x		x				A
Malacanthidae	*Malacanthus brevirostris*	x							A
Serranidae	*Cephalopholis argus*	x			x	x	x		C/A
	Cephalopholis miniata	x				x	x		C/A
	Variola louti	x			x		x		C/A
Dasyatidae	*Dasyatis kuhlii*						x		C/A
Lutjanidae	*Lutjanus kasmira*	x			x				C/A
	Macolor niger	x							C/A
Mullidae	*Parupeneus cyclostomus*	x		x	x				C/A
Plotosidae	*Platax orbicularis*						x		C/A
Pomacanthidae	*Pomacanthus chysurus*						x		C/A
	Pomacanthus imperator	x			x		x		C/A
	Pomacanthus semicirculatus						x		C/A
Balistidae	*Balistapus undulatus*						x		C/A
	Pseudobalistes fuscus						x		C/A
	Rhinecanthus aculeatus		x						C/A
Siganidae	*Siganus stellatus*	x	x	x	x	x			C/A