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Marine and Freshwater Research

Supplementary Material

Functional responses of mangrove fauna to forest degradation

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Material and methods

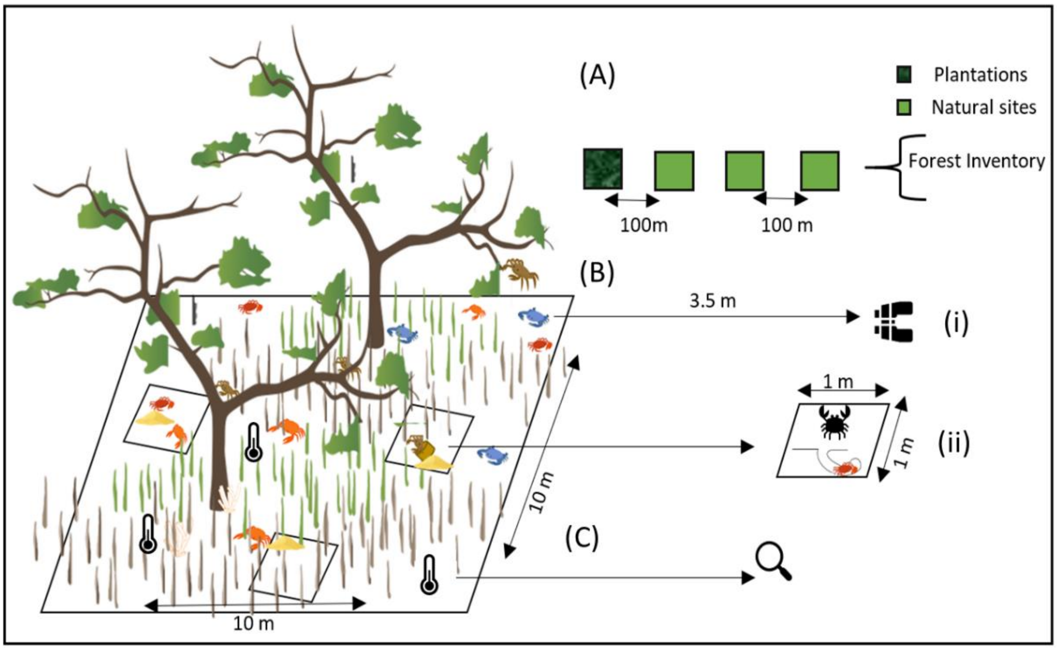

Figure S1. Overview of the three-step approach per forest plot. A) Mangrove forest structure assessment using plots kept 100 m apart from each other and plantation sites, B) macrofaunal abundance and taxonomy quantification in three sub-quadrats (1 × 1 m) using: (i) binoculars observations of crab species and (ii) counts of crab burrows and assessment of epifaunal diversity. C) Biophysical parameters were measured at three points within the plot.

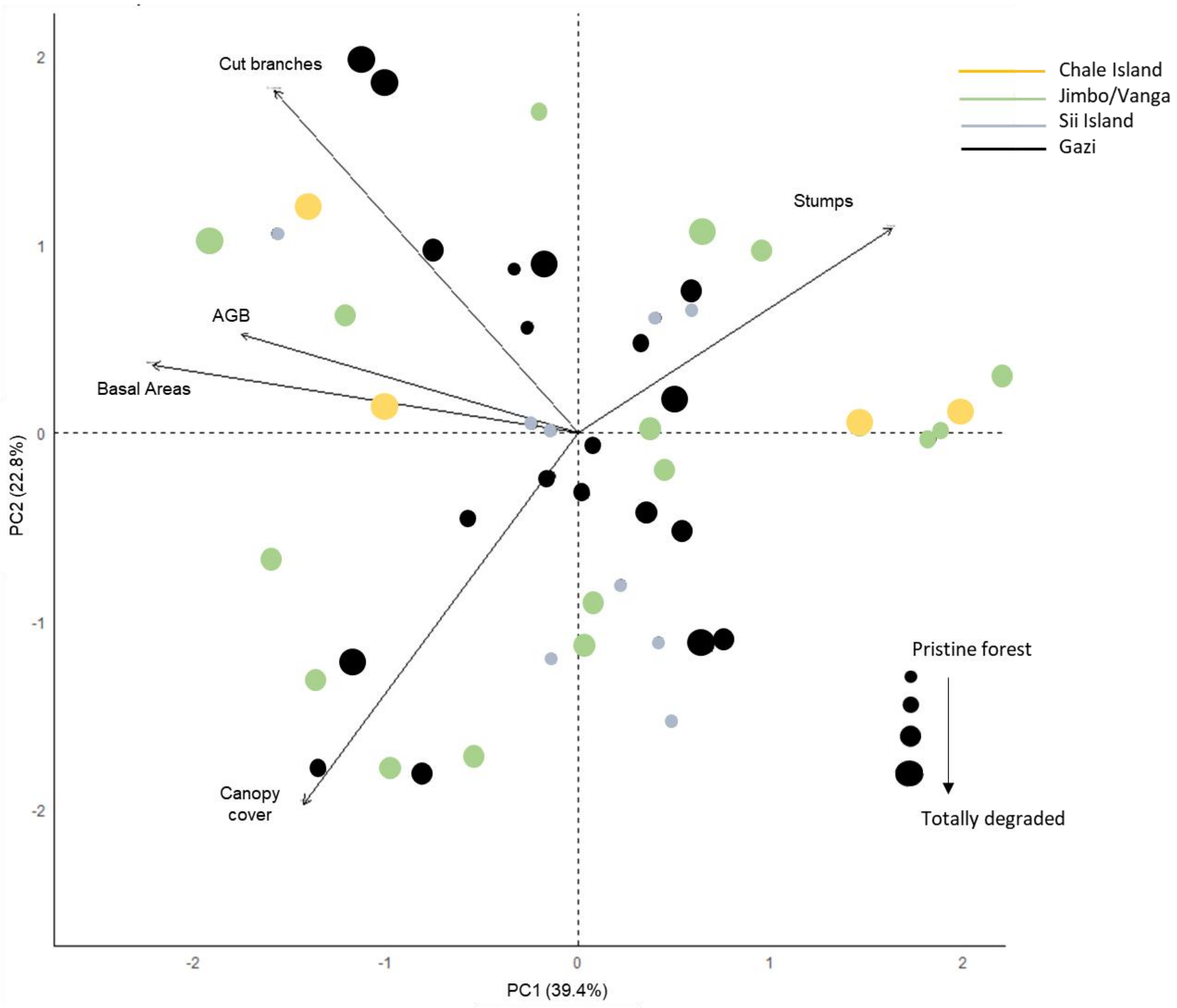

Figure S2. Principal component analysis (PCA) showing relationships among mangrove forest variables. Each dot in the PCA represents mangrove plots based on normalised data.

Results

A principal component analysis (PCA) was executed on the whole forest factors and biophysical parameters with previous normalisation of data. The PCA aimed to reduce the number of forest and biophysical factors to cover as much inter-site variability as possible. Following Zuur *et al*. (2007), the results of scree plot and eigenvalues were used to retain and present a maximum number of components. A clustering algorithm (K-means) analysis was used to reduce the number of data-points and identify classes of degradation (Faber 1994). Exploratorily analyses showed that assumptions of homogeneity of variance and normality of residuals were met. Plot differentiation along PC1, which explained 39.4% of the variation among plots, was mainly driven by the higher loading of basal area (m^2) and AGB (Mg ha^{-1}) and stump density (stumps ha^{-1}). Conversely, plot differentiation along PC2 (22.8% of variation) was explained by canopy cover (%), cut branches (branches ha^{-1}); with basal area (m^2) and AGB (Mg ha^{-1}) have little influence to the PC2. In effect, canopy cover (%) and stump density (stumps ha^{-1}) were negatively correlated to each other, and although they contribute to both axes, were more influenced by PC2 and PC1 respectively. The right angle created between cut branches (branches ha^{-1}) and stump density (stumps ha^{-1}) suggested the small correlation between the two variables. Here, basal area and AGB (Mg ha^{-1}) vectors showed the strongest correlation to each other and to PC1, with the other correlations being only marginals. Overall, the PCA indicated canopy cover had a positive, although minimal association with the other observed forest factors.

Environmental factor analysis

Canopy cover was tested against the other remaining forest factors as a proxy for forest and showed a positive regression with AGB (Mg ha^{-1}), basal area (m2 ha^{-1}) and stump density (stumps ha^{-1}) and a negative regression with cut branch density (branches ha^{-1}, Table 2). Mixed linear models were used to test for relationships of biophysical variables (temperature, salinity, grain size, pH) with canopy cover. Comparison along the gradient in canopy cover showed that there were no significant trends for soil temperature ($P = 0.14$), soil salinity ($P = 0.13$) and grain size ($P = 0.12$). Shading diminished with a reduction of canopy cover ($F = 37.1$, d.f. = 45, $P = 0.001$, $R^2 = 0.4$, $\beta = 1.36$, Figure S3a), whereas pH increased ($F = 46.5$, d.f. = 45, $P = 0.001$, $R^2 = 0.5$, $\beta = 0.6$, Figure S3b)

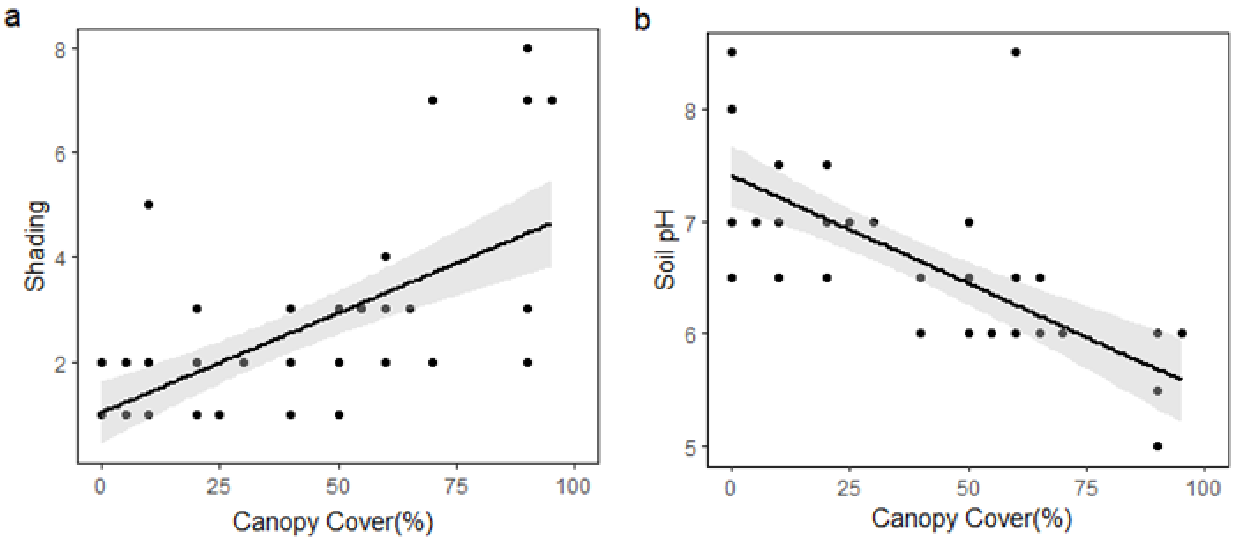

Figure S3. Relationships of (a) Shading (the difference between outside and inside canopy temperature and (b) Soil pH and mangrove Canopy Cover (%)

Table S1. The mean, standard deviation (±), minimum and maximum range in the values of forest variables, clustered under four sampling sites.

Sites (*n* plots)	Variables	Mean	s.d.	Max	Min
Gazi (19)	Canopy Cover (%)	44.5	27.6	90	0
	Cut branch density (m^{-2})	11.6	10.6	36	0
	Stump density (m^{-2})	4.6	6.7	26	0
	Basal area (m^2 ha^{-1})	108.1	169.5	1300.3	4.2
	AGB (Mg ha^{-1})	1453.1	988.8	3985.8	320.8
Chale (4)	Canopy Cover (%)	28.8	33.3	60	0
	Cut branch density (m^{-2})	2.8	3.4	7	0
	Stump density (m^{-2})	8.0	9.8	20	0
	Basal area (m^2 ha^{-1})	81.9	101.6	463.5	0
	AGB (Mg ha^{-1})	610.9	706.8	1275.7	0
Jimbo/Vanga (18)	Canopy Cover (%)	21.2	19.8	60	0
	Cut branch density (m^{-2})	15.3	17.5	75	0
	Stump density (m^{-2})	10.5	21.0	100.0	0
	Basal area (m^2 ha^{-1})	257.4	517.8	4899.2	0
	AGB (Mg ha^{-1})	2331.5	3648.3	16221.3	0
Sii Island (9)	Canopy Cover (%)	72.5	17.9	95	50
	Cut branch density (m^{-2})	0.9	2.5	7	0
	Stump density (m^{-2})	0.4	0.7	2	0
	Basal area (m^2 ha^{-1})	11936.9	2417.3	13136.6	42.2
	AGB (Mg ha^{-1})	36867.3	46184.2	119230.3	1762.7

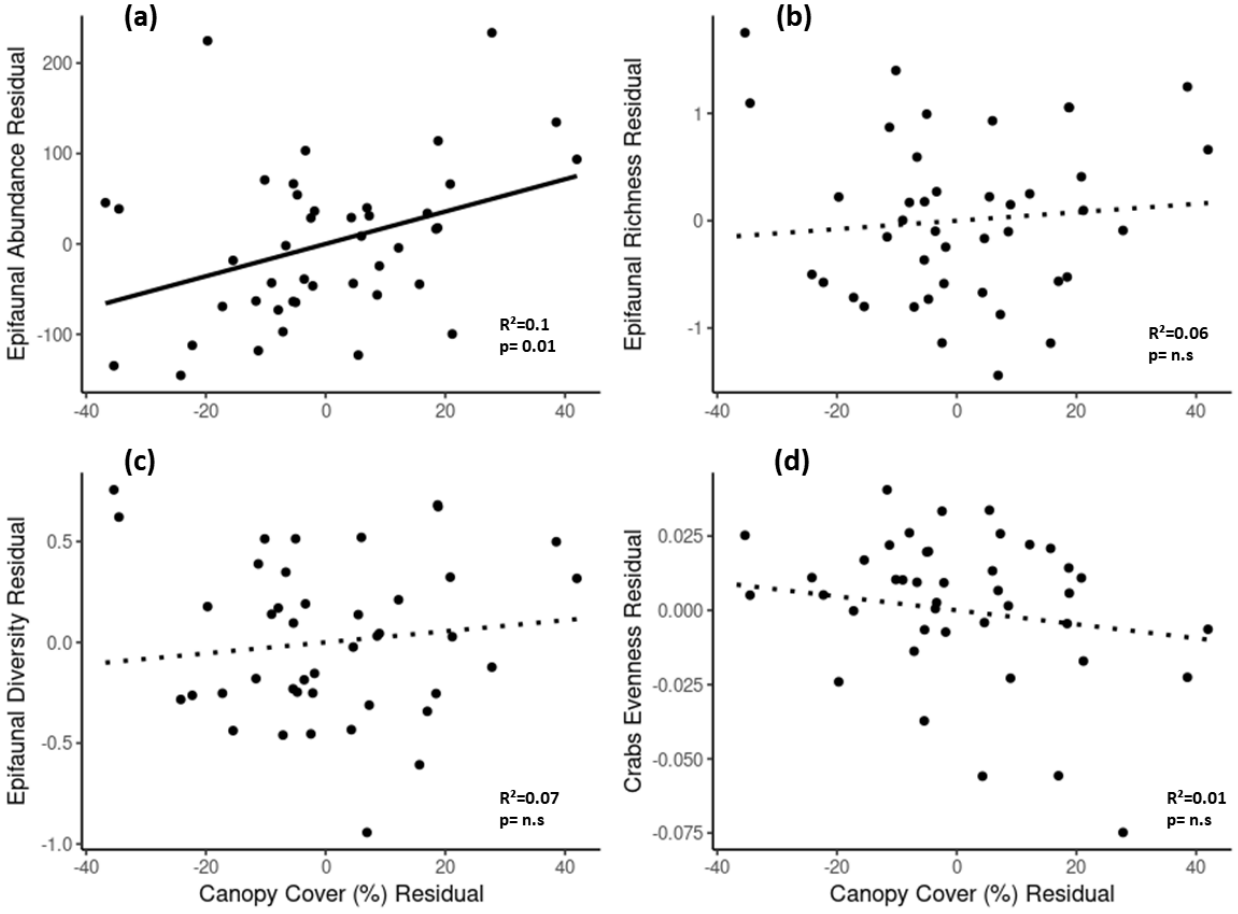

Figure S4. Partial regression plots showing the influences of epibenthic fauna residuals composition with canopy cover residual: (a) abundance, (b) richness, (c) diversity and (e) evenness.

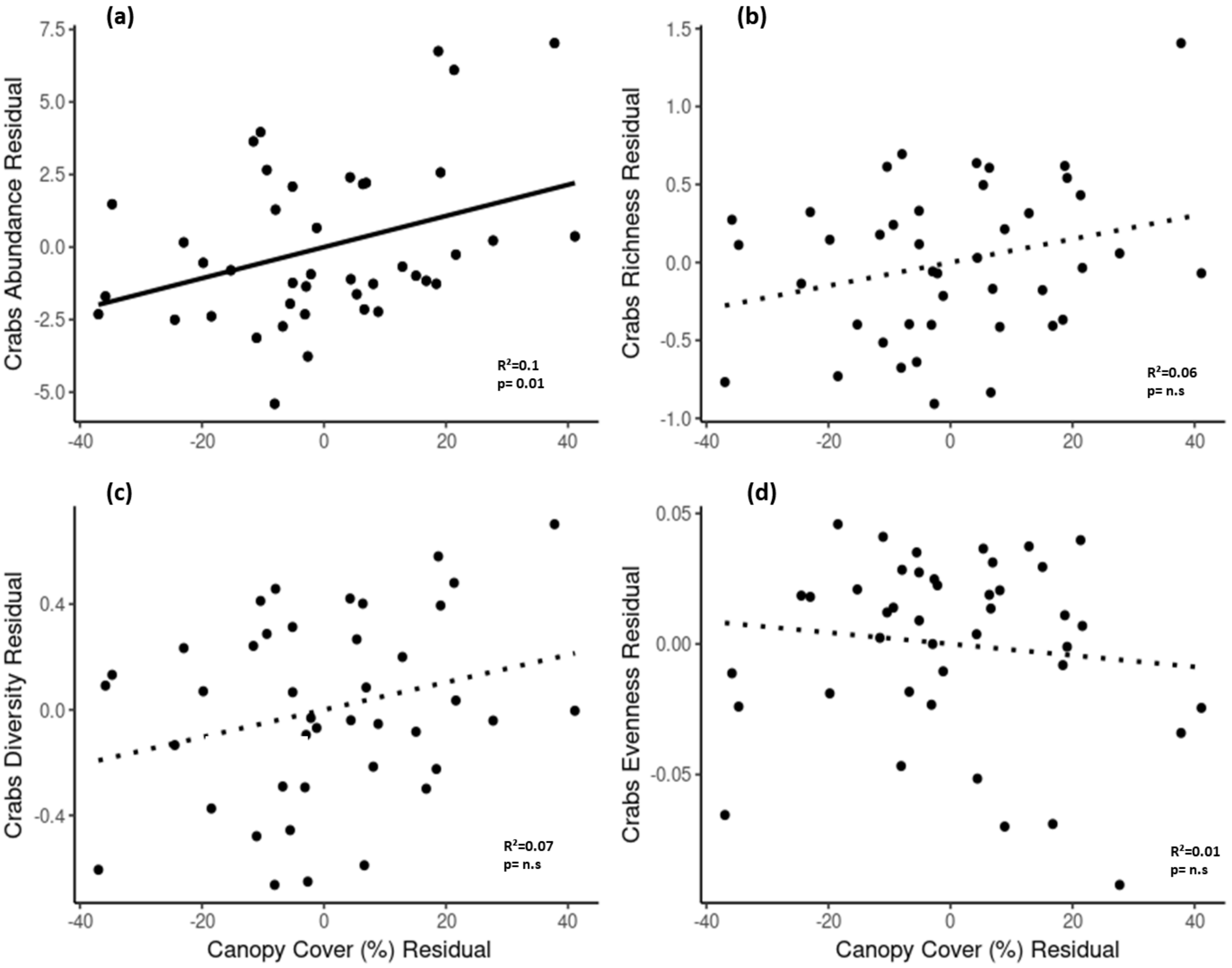

Figure S5. Partial regression plots showing the influences of crabs residuals composition with canopy cover residual: (a) abundance, (b) richness, (c) diversity and (e) evenness.

References

Faber, V. (1994). Clustering and the continuous *k*-means algorithm. *Los Alamos Science* **22**, 138–144.

Zuur, A., Ieno, E. N., and Smith, G. M. (2007) 'Analyzing ecological data.' (Springer)