The following supplement accompanies the article

Quantifying wave exposure in shallow temperate reef systems: applicability of fetch models for predicting algal biodiversity

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Supplement: Details of bathymetry altered fetch calculations

As waves propagate into water shallow enough for orbital motion in the trough to be eliminated (water depth ≤ 0.5 wavelength), wave length and velocity decrease while wave height increases (Denny 1998, Woodroffe 2003) which transforms the waves fundamentally. For example, this can lead to changes in wave direction (refraction) which cartographic fetch-based wave exposure models, including GREMO, ignore. However, shoaling waves also experience a gradual loss of energy due to interaction with the sea bottom and breaking (Carniello et al. 2005, Woodroffe 2002). GREMO addresses the energy loss from the former using an algorithm modified from Malhotra & Fonseca (2007) to adjust fetch line lengths based on local bathymetry (Pepper & Puotinen 2009). Using this equation (Eq. S1), the new fetch length (f_i) for each fetch line i is calculated as:

$$f_i = \sum_{j=0}^{L_i/n} \left[1/(D_j)^{Pw}(1 - D_j/L_i)\right] Z_j \qquad \text{(S1)}$$

where:

f_i is the adjusted length for *i*th radiating fetch line;
D_j is the *j*th distance along the fetch line from the site;
L_i is the length of the *i*th fetch line;
Z_j is the depth at the distance D_j along the *i*th fetch line;
n is the fixed distance for raster sampling; and
P_w is the power function controlling the degree of weighting bathymetry at the D_j distance along a fetch line (in this study, set to 0.5).

By splitting each fetch line into n segments, changes in bathymetry along the line are considered. Further, because changes in depth closer to a given site of interest are more important to determining wave exposure at that site that those that occur further away (Murphey & Fonseca 1995), an inverse distance weighting (IDW) is used to weight adjustments to the fetch line based on how close each segment under consideration is to the site (Fig. S1).

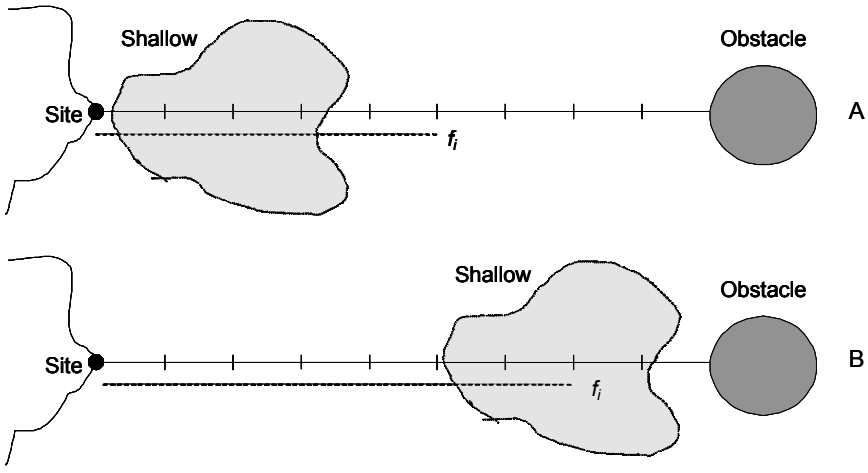

Fig. S1. The length of each fetch line L_i is adjusted to f_i by the algorithm (Eq. S1) based on the water depth (Z_j) encountered at each interval D_j along the line (intervals each equal to n distance). The weighting of water depth decreases with distance from the site: shallow water near the site results in a shorter f_i in (A) than in (B) where shallow water is found farther away from the site. The power function P_w controls the strength of this adjustment and is defined based on wave height fetch graphs for a given wind speed and typical water depth using the US Army Corps of Engineers Shore Protection Manual (Vol 1)

The power function controls the degree of weighting bathymetry along the sampling intervals of the fetch line, and thus the overall attenuation of the fetch line. Malhotra & Fonseca (2007) assigned values of P_w to each fetch line based on the dominant wind speed along that line using wave height versus fetch graphs from the US Army Corps of Engineers Shore Protection Manual (USCOE, Shore Protection Manual, Vol. 1) at 2 depths characteristic of their study sites (1.5 m and 3.05 m). As wind speed increases for a given fetch over a given bathymetry, larger waves can form because more energy is available to offset the dampening effect of the shallow water. However, power values recorded in Malhotra & Fonseca (2007) cannot be used accurately in environments with depths >3 m. An analysis by Pepper (2009) examined a series of plausible power values and their relation to average depth and the length of the fetch line. Based on this series, a value of 0.5 was chosen as the power value.

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Table S1. Model statistics for all models used to predict the occurrence of each algal genus or group. Data were analysed using GLMs with binomial errors and a logit link function. Statistics reported are (1) terms included in the model, (2) number of parameters estimated in the model (k), (3) log-likelihood of the model (LogL), (4) the change in Akaike's Information Criteria between models (dAIC), (5) AIC weight (wAIC), (6) percent deviance explained by the model (%DE)

Alga (genus)	Model	k	LogL	dAIC	wAIC	% DE	Alga (genus)	Model	k	LogL	dAIC	wAIC	% DE
Acrocarpia	PWC + PWC^2	3	-33.75	0.00	0.969	37.49	*Ecklonia*	Bathy	2	-31.63	0.00	0.312	6.01
	Open + Open^2	3	-37.26	7.03	0.029	30.98		90_Hs	2	-32.03	0.81	0.208	4.81
	Wind + Wind^2	3	-39.73	11.96	0.002	26.41		PWC	2	-32.16	1.06	0.184	4.44
	90_Hs + 90_Hs^2	3	-44.54	21.58	0.000	17.50		Null	1	-33.65	2.05	0.112	0.00
	Mean_Hs + Mean_Hs^2	3	-49.23	30.95	0.000	8.82		Open	2	-32.89	2.51	0.089	2.28
	Bathy + Bathy^2	3	-49.40	31.31	0.000	8.49		Wind	2	-33.44	3.63	0.051	0.63
	Null	1	-53.99	36.48	0.000	0.00		Mean_Hs	2	-33.60	3.94	0.044	0.16
Carpoglossum	Open	2	-42.07	0.00	0.803	22.44	*Lessonia*	Bathy + Bathy^2	3	-30.70	0.00	1.000	31.31
	Wind	2	-43.63	3.11	0.169	19.57		Open + Open^2	3	-39.76	18.11	0.000	11.05
	Bathy	2	-45.75	7.36	0.020	15.65		Wind + Wind^2	3	-40.12	18.83	0.000	10.24
	PWC	2	-46.85	9.55	0.007	13.64		PWC	2	-41.79	20.18	0.000	6.50
	90_Hs + 90_Hs^2	3	-48.51	14.88	0.000	10.56		Mean_Hs	2	-43.62	23.84	0.000	2.40
	Mean_Hs + Mean_Hs^2	3	-51.78	21.42	0.000	4.54		Null	1	-44.70	23.99	0.000	0.00
	Null	1	-54.24	22.34	0.000	0.00		90_Hs	2	-43.95	24.51	0.000	1.66
Caulerpa	Bathy	2	-40.66	0.00	0.996	23.15	*Phyllospora*	Bathy	2	-36.95	0.00	1.000	30.71
	PWC + PWC^2	3	-46.03	12.73	0.002	13.01		Open	2	-49.19	24.49	0.000	7.75
	Open + Open^2	3	-46.10	12.87	0.002	12.88		Mean_Hs + Mean_Hs^2	3	-48.47	25.04	0.000	9.11
	Wind + Wind^2	2	-49.03	16.74	0.000	7.33		90_Hs + 90_Hs^2	3	-49.94	27.98	0.000	6.35
	Mean_Hs + Mean_Hs^2	3	-48.57	17.82	0.000	8.21		Wind	2	-51.08	28.26	0.000	4.22
	Null	1	-52.92	22.50	0.000	0.00		PWC + PWC^2	3	-50.33	28.76	0.000	5.63
	90_Hs + 90_Hs^2	3	-51.22	23.12	0.000	3.19		Null	1	-53.33	30.76	0.000	0.00
Cystophora	Open + Open^2	3	-43.01	0.00	0.439	15.22	*Sargassum*	90_Hs + 90_Hs^2	3	-38.21	0.00	0.937	25.61
	PWC + PWC^2	3	-43.45	0.87	0.284	14.36		Mean_Hs + Mean_Hs^2	3	-41.03	5.65	0.055	20.11
	Bathy	2	-44.73	1.44	0.214	11.83		Wind + Wind^2	3	-43.96	11.50	0.003	14.41
	Wind + Wind^2	3	-45.02	4.01	0.059	11.27		Open + Open^2	3	-43.96	11.51	0.003	14.40
	Mean_Hs	2	-49.37	10.72	0.002	2.68		PWC + PWC^2	3	-44.66	12.92	0.001	13.04
	Null	1	-50.73	11.44	0.001	0.00		Bathy + Bathy^2	3	-46.67	16.93	0.000	9.13
	90_Hs	2	-50.52	13.02	0.001	0.42		Null	1	-51.36	22.31	0.000	0.00
Durvillaea	Bathy	2	-32.86	0.00	0.796	28.17	*Zonaria*	PWC + PWC^2	3	-38.03	0.00	0.906	21.60
	Mean_Hs + Mean_Hs^2	3	-33.35	2.99	0.179	27.09		90_Hs + 90_Hs^2	3	-40.94	5.82	0.049	15.60
	PWC + PWC^2	3	-35.44	7.15	0.022	22.54		Open + Open^2	3	-41.51	6.96	0.028	14.42
	90_Hs + 90_Hs^2	3	-37.99	12.26	0.002	16.95		Wind + Wind^2	3	-42.14	8.22	0.015	13.13
	Open + Open^2	3	-38.63	13.55	0.001	15.55		Bathy	2	-45.66	13.25	0.001	5.88
	Wind + Wind^2	3	-40.20	16.68	0.000	12.12		Mean_Hs + Mean_Hs^2	3	-44.95	13.83	0.001	7.34
	Null	1	-45.75	23.77	0.000	0.00		Null	1	-48.51	16.95	0.000	0.00

Table S2. Model statistics for all models used to predict the percent cover of each algal genus or group. Data were arcsine-square root transformed (excepting canopy, understorey and encrusting algae) and analysed using GLMs with a Gaussian error structure and identity link function. Statistics reported are (1) terms included in the model, (2) number of parameters estimated in the model (k), (3) log-likelihood of the model (LogL), (4) the change in Akaike's Information Criteria between models (dAIC), (5) AIC weight (wAIC), (6) percent deviance explained by the model (%DE)

Alga (genus or group)	Model	k	LogL	dAIC	wAIC	% DE	Alga (genus or group)	Model	k	LogL	dAIC	wAIC	% DE
Acrocarpia	Open + Open^2	3	14.63	0.00	0.789	35.60	*Phyllospora*	Bathy + Bathy^2	3	-19.56	0.00	1.000	34.23
	PWC + PWC^2	3	13.28	2.70	0.204	33.36		Open + Open^2	3	-28.30	17.48	0.000	17.95
	Wind + Wind^2	3	9.83	9.61	0.006	27.27		PWC + PWC^2	3	-29.60	20.09	0.000	15.19
	Bathy	2	0.92	25.43	0.000	8.87		Wind	2	-32.78	24.44	0.000	8.09
	90_Hs	2	-1.08	29.44	0.000	4.13		Mean_Hs	2	-33.07	25.02	0.000	7.41
	Mean_Hs	2	-1.58	30.42	0.000	2.93		90_Hs + 90_Hs^2	3	-33.72	28.32	0.000	5.87
	Null	1	-2.75	30.77	0.000	0.00		Null	1	-36.11	29.10	0.000	0.00
Carpoglossum	Open + Open^2	3	51.45	0.00	0.834	34.30	*Sargassum*	90_Hs + 90_Hs^2	3	54.23	0.00	0.949	27.94
	Wind + Wind^2	3	49.84	3.23	0.166	31.56		Mean_Hs + Mean_Hs^2	3	51.29	5.88	0.050	22.37
	PWC + PWC^2	3	43.76	15.38	0.000	20.18		Bathy	2	45.06	16.36	0.000	9.09
	Bathy + Bathy^2	3	41.98	18.94	0.000	16.50		Open	2	44.40	17.67	0.000	7.57
	90_Hs + 90_Hs^2	3	38.55	25.80	0.000	8.93		Wind	2	44.35	17.76	0.000	7.46
	Null	1	34.86	29.19	0.000	0.00		PWC	2	43.92	18.64	0.000	6.43
	Mean_Hs	2	34.90	31.10	0.000	0.11		Null	1	41.29	21.89	0.000	0.00
Caulerpa	Mean_Hs + Mean_Hs^2	3	54.77	0.00	0.991	30.51	*Zonaria*	Bathy	2	59.83	0.00	0.698	16.15
	90_Hs + 90_Hs^2	3	49.83	9.86	0.007	21.27		90_Hs	2	58.63	2.41	0.209	13.55
	Bathy + Bathy^2	3	48.03	13.47	0.001	17.60		Mean_Hs	2	56.82	6.02	0.034	9.51
	PWC	2	45.02	17.49	0.000	11.06		PWC + PWC^2	3	57.73	6.21	0.031	11.56
	Open	2	44.85	17.83	0.000	10.68		Open + Open^2	3	57.40	6.87	0.022	10.81
	Wind	2	44.40	18.73	0.000	9.66		Wind + Wind^2	3	55.14	11.39	0.002	5.56
	Null	1	40.39	24.76	0.000	0.00		Null	1	52.88	11.91	0.002	0.00
Cystophora	Open + Open^2	3	26.92	0.00	0.800	20.36	Encrusting	Mean_Hs	2	-356.50	0.00	0.706	16.22
	Wind + Wind^2	3	24.63	4.58	0.081	15.60		90_Hs	2	-357.60	2.19	0.236	13.86
	PWC + PWC^2	3	24.40	5.04	0.064	15.11		Bathy	2	-359.68	6.35	0.029	9.20
	Bathy	2	23.17	5.49	0.051	12.44		PWC + PWC^2	3	-359.01	7.03	0.021	10.71
	Mean_Hs	2	19.75	12.33	0.002	4.52		Open + Open^2	3	-360.39	9.78	0.005	7.55
	90_Hs	2	19.38	13.08	0.001	3.61		Null	1	-363.49	11.98	0.002	0.00
	Null	1	17.93	13.98	0.001	0.00		Wind + Wind^2	3	-362.18	13.36	0.001	3.26
Durvillaea	Bathy + Bathy^2	3	0.65	0.00	0.549	18.56	Understorey	Bathy	2	-340.91	0.00	0.999	28.79
	90_Hs	2	-0.76	0.83	0.363	15.59		PWC + PWC^2	3	-346.99	14.15	0.001	16.95
	Mean_Hs + Mean_Hs^2	3	-1.64	4.58	0.056	13.70		Open + Open^2	3	-347.35	14.87	0.001	16.20
	Wind	2	-3.77	6.85	0.018	8.91		Wind + Wind^2	3	-351.43	23.04	0.000	7.06
	Open	2	-4.27	7.85	0.011	7.75		Mean_Hs + Mean_Hs^2	3	-351.99	24.16	0.000	5.73
	PWC	2	-5.60	10.51	0.003	4.59		Null	1	-354.32	24.82	0.000	0.00
	Null	1	-7.46	12.22	0.001	0.00		90_Hs + 90_Hs^2	3	-352.90	25.97	0.000	3.55

Ecklonia	Bathy + Bathy^2	3	3.29	0.00	0.535	9.25	Canopy	Bathy + Bathy^2	3	-374.37	0.00	0.530	29.70
	90_Hs	2	1.37	1.84	0.213	4.73		Open + Open^2	3	-374.60	0.47	0.419	29.28
	Null	1	-0.55	3.67	0.085	0.00		Wind + Wind^2	3	-376.71	4.68	0.051	25.41
	Wind	2	0.01	4.55	0.055	1.41		PWC	2	-382.74	14.75	0.000	13.10
	Mean_Hs	2	-0.28	5.14	0.041	0.67		Mean_Hs	2	-386.81	22.88	0.000	3.68
	PWC	2	-0.34	5.25	0.039	0.53		Null	1	-388.29	23.84	0.000	0.00
	Open	2	-0.51	5.59	0.033	0.10		90_Hs + 90_Hs^2	3	-386.72	24.70	0.000	3.91
Lessonia	Bathy + Bathy^2	3	76.31	0.00	0.991	20.47							
	Mean_Hs	2	69.26	12.09	0.002	4.94							
	Open	2	69.12	12.37	0.002	4.61							
	PWC	2	69.12	12.39	0.002	4.59							
	90_Hs	2	68.41	13.79	0.001	2.87							
	Null	1	67.26	14.10	0.001	0.00							
	Wind + Wind^2	3	69.23	14.17	0.001	4.86							