

## Linking environmental variables with regional-scale variability in ecological structure and standing stock of carbon within kelp forests in the United Kingdom

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Table S1. Reported values for carbon content of kelp species, as a percentage of dry weight (list is not exhaustive).

<b>Kelp species</b>	<b>Region</b>	<b>C (% of DW)</b>	<b>No. inds.</b>	<b>Reference</b>
<i>Laminaria digitata</i>	Northern France	29.1	197	(Gevaert et al. 2008)
<i>Laminaria digitata</i>	Nova Scotia	32.7	3	(Mann 1972)
<i>Laminaria digitata</i>	Rhode Island	26.9	3	(Brady-Campbell et al. 1984)
<i>Laminaria hyperborea</i>	Norway	31.3	>32	(Sjøtun et al. 1996)
<i>Laminaria solidungula</i>	Arctic	32.5	>30	(Dunton & Schell 1986)
<i>Saccharina latissima</i>	Rhode Island	31.5	6	(Brady-Campbell et al. 1984)
<i>Saccharina latissima</i>	Northern France	28	182	(Gevaert et al. 2001)
<i>Saccharina longicuris</i>	Nova Scotia	29.3	10	(Mann 1972)
		<b>Mean: 30.16</b>		

#### Literature cited

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- Gevaert F, Janquin MA, Davoult D (2008) Biometrics in *Laminaria digitata*: A useful tool to assess biomass, carbon and nitrogen contents. 60:215-219
- Mann KH (1972) Ecological energetics of the seaweed zone in a marine bay on the Atlantic coast of Canada: I. Zonation and biomass of seaweeds. Mar Biol 12:1-10
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Table S2. Results of DISTLM tests linking environmental predictor variables with kelp canopy density, canopy biomass and standing stock of carbon. Canopy biomass and Total carbon were log-transformed prior to analysis. Marginal tests for each predictor variable are shown below, with the most parsimonious models based on AICc selection criteria shown in Table 4. SS = sum of squares; Prop. = Proportion of variation explained.

(A) *Canopy density*

<b>Variable</b>	<b>SS</b>	<b>F</b>	<b>P</b>	<b>Prop.</b>
Summer max. temp.	7.971	2.6494	0.14	0.21
Summer daytime light	0.51844	0.1381	0.702	0.01
Depth	0.0078	0.0023	0.982	0.01
Large scale fetch	29.639	35.205	0.001	0.78
Water motion (waves)	21.396	12.842	0.003	0.56
Water motion (tides)	1.51	0.415	0.538	0.04
Urchin density	2.1477	0.5980	0.477	0.05
log Chlorophyll a	16.812	7.9136	0.017	0.44
Phosphate	2.4409	0.6853	0.442	0.06
Nitrate+nitrite	2.3998	0.6730	0.416	0.03

(B) *Canopy biomass*

<b>Variable</b>	<b>SS</b>	<b>F</b>	<b>P</b>	<b>Prop.</b>
Summer max. temp.	0.2554	4.3321	0.068	0.30
Summer daytime light	0.3212	6.1428	0.040	0.38
Depth	0.0378	0.4684	0.507	0.04
Large scale fetch	0.0264	0.3225	0.570	0.03
Water motion (waves)	0.0726	0.9391	0.384	0.08
Water motion (tides)	0.0631	0.8061	0.381	0.07
Urchin density	0.0002	0.0032	0.951	0.01
log Chlorophyll a	0.0792	1.0341	0.331	0.09
Phosphate	0.0217	0.2636	0.640	0.02
Nitrate+nitrite	2.4955	0.3049	0.579	0.03

(c) *Total carbon standing stock*

<b>Variable</b>	<b>SS</b>	<b>F</b>	<b>P</b>	<b>Prop.</b>
Summer max. temp.	0.17653	2.8612	0.112	0.22
Summer daytime light	0.2308	4.1024	0.084	0.29
Depth	0.0319	0.4193	0.557	0.04
Large scale fetch	0.0487	0.6551	0.457	0.06
Water motion (waves)	0.0935	1.3364	0.270	0.11
Water motion (tides)	0.0177	0.2290	0.626	0.02
Urchin density	0.0071	0.0915	0.794	0.01
log Chlorophyll a	0.0713	0.9875	0.325	0.08
Phosphate	0.0025	0.0315	0.878	0.01
Nitrate+nitrite	0.0023	0.0290	0.873	0.01

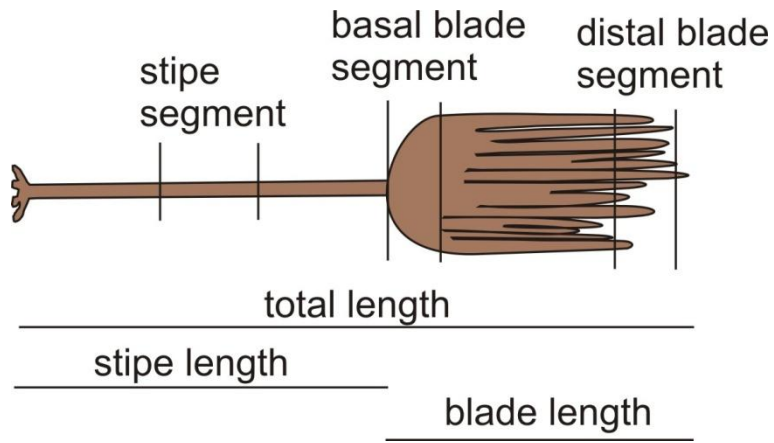


Fig S1. Schematic of kelp thallus to show segments obtained for dry versus fresh weight analysis and morphological measurements taken for each canopy-forming sporophyte.

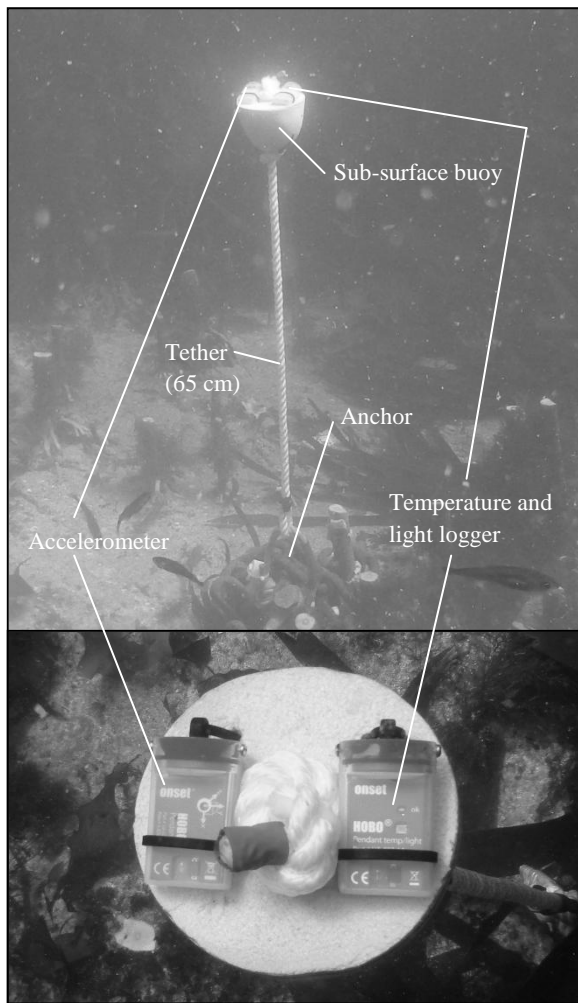


Figure S2. Deployment of light, temperature and water motion sensors in subtidal kelp forests. Data sensors were attached to a sub-surface pellet buoy, which was tethered to the seabed using anchor chain and rope.

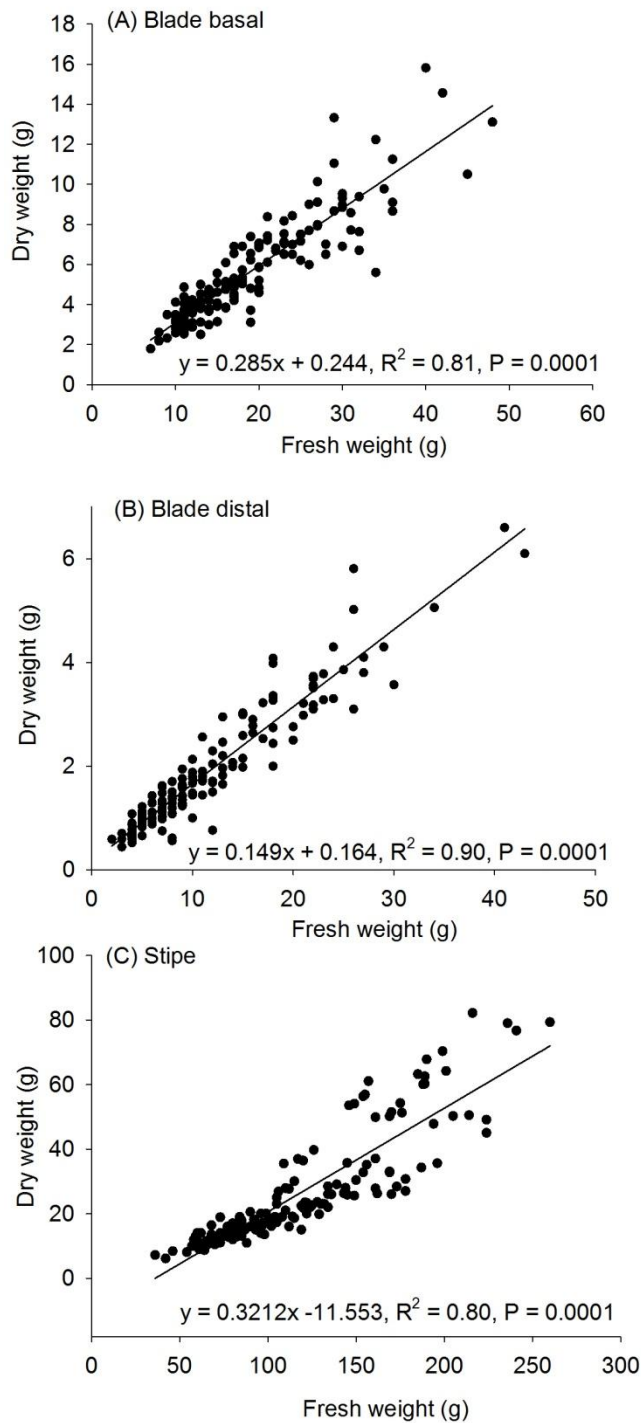


Figure S3. Relationships between fresh and dry weight for kelp tissue derived from basal (a) and distal (b) sections of the blade as well as the stipe (c). Biomass data were generated from 47 kelp plants collected from N Scotland, 13 from W Scotland, 48 from SW Wales and 46 from SW England.

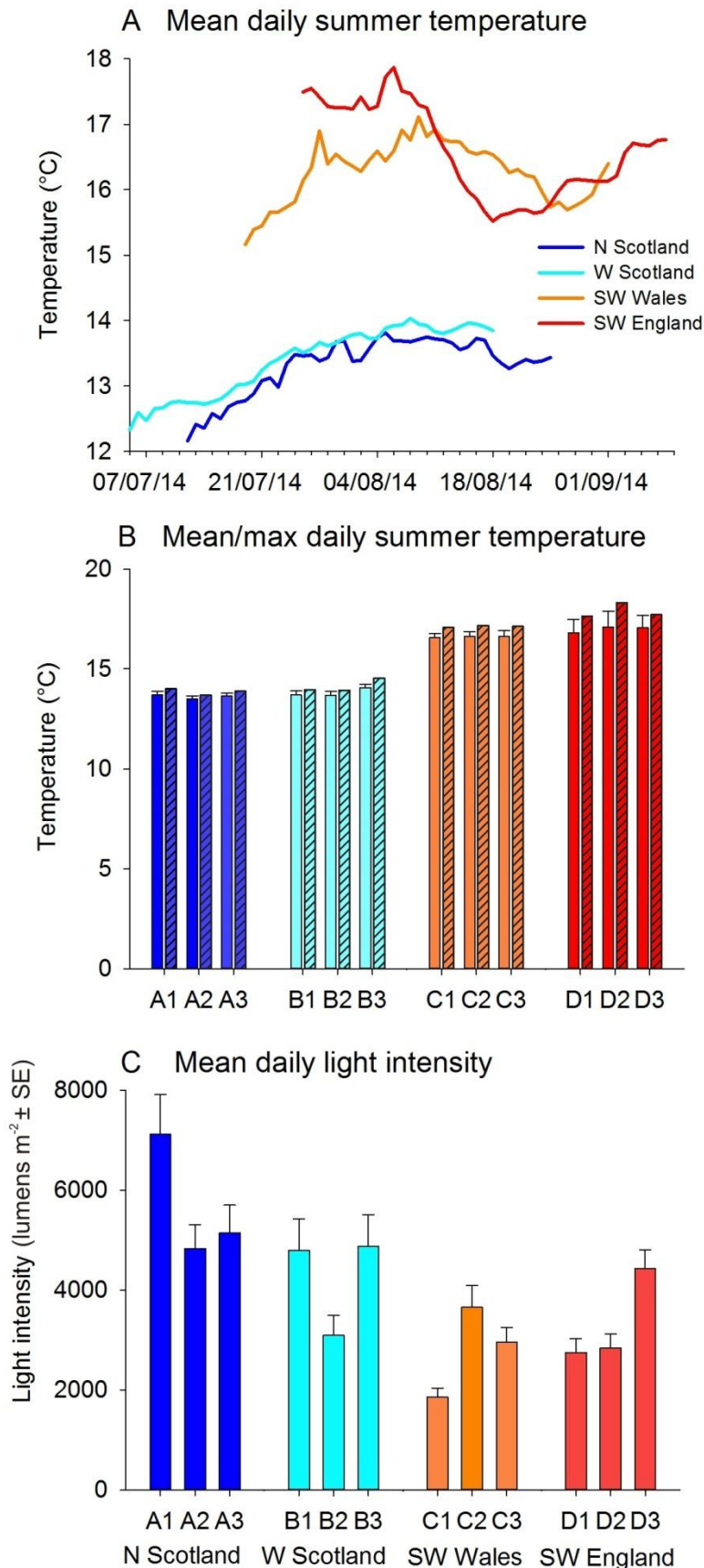


Figure S4. Light and temperature conditions recorded during summer 2014 at the study sites. A: Mean daily temperature recorded within each region (average of 3 sites) throughout logger deployment. B: Mean (non-hatched bars) and maximum (hatched bars) daily temperature recorded at each site during 24 overlapping deployment days during summer 2014 (26<sup>th</sup> July – 18<sup>th</sup> August). C: Mean daytime light intensity recorded at each study site in summer 2014 (calculated from 14 days of data following logger deployment, based on daytime values only; 0800 to 2000 hours). Site names correspond to those in Figure 1.

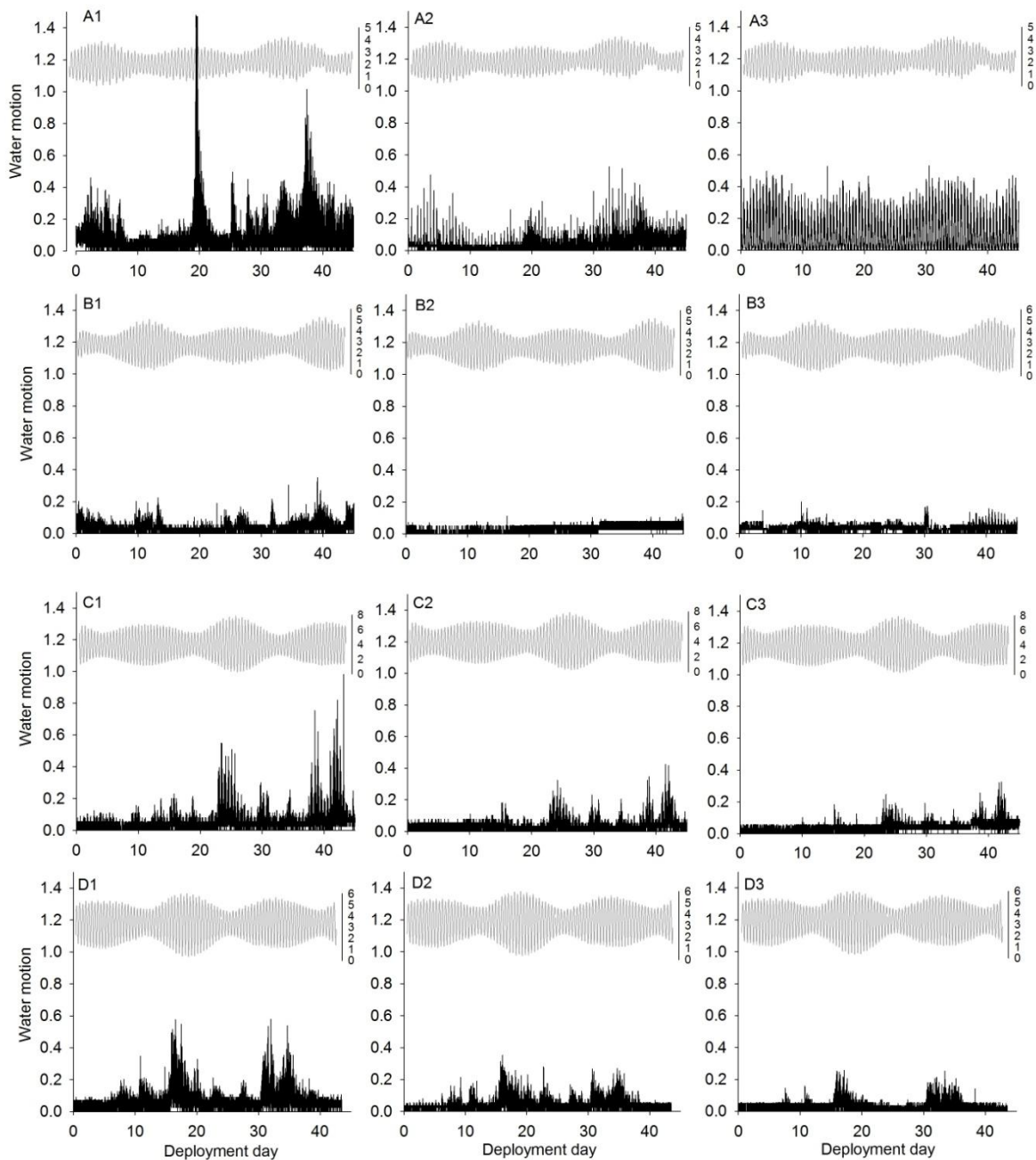


Figure S5. Water motion recorded by accelerometers at each study site during summer 2014. Values are estimated  $\text{ms}^{-1}$  recorded during 45 day deployment of sensor array. Tidal cycles derived from sea level readings from each study region are also shown. Data were obtained from the following tidal gauges: N Scotland (sites A1-A3): Wick; W Scotland (sites B1-B3): Tobermory; SW Wales (sites C1-C3): Milford Haven; SW England (sites D1-D3): Devonport (sea level data are managed and distributed by the British Oceanographic Data Centre, [www.bodc.ac.uk](http://www.bodc.ac.uk)). Site names correspond to those in Figure 1.



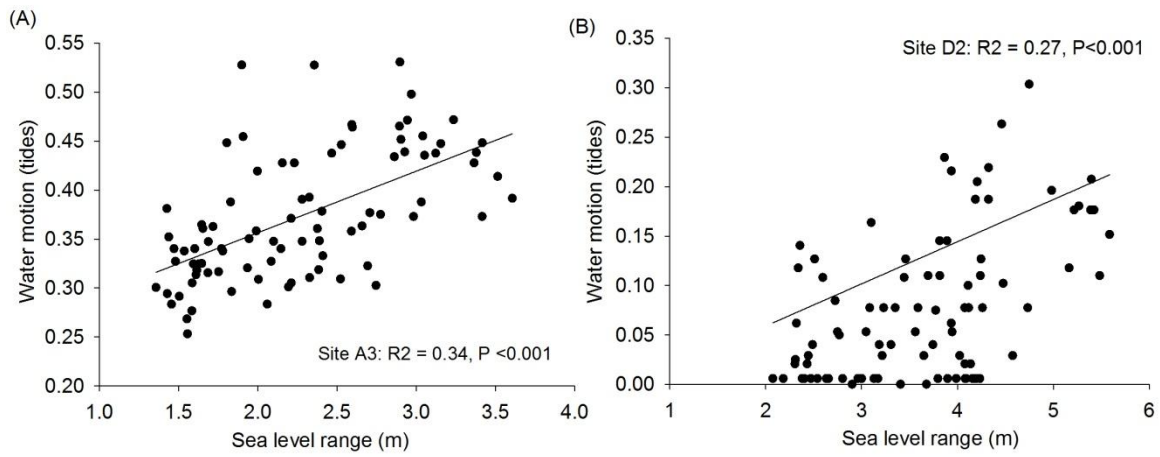


Fig. S6. Relationship between the metric derived to quantify tidal motion (from *in situ* accelerometers) and range in sea level for each 12-hour period during the 45-day sensor deployment ( $n = 90$ ). Data are shown for 2 representative sites, North Grahamsay in northern Scotland (site A3) and Stoke Point in southwest England (site D2). As expected, there was a positive relationship between the variables, with periods of high diurnal sea level variability (i.e. during spring tides) corresponding with high values of water motion induced by tidal flow.