Supplement of Biogeosciences, 17, 2041–2059, 2020
https://doi.org/10.5194/bg-17-2041-2020-supplement

Biogeosciences
Open Access

Supplement of

Drivers and modelling of blue carbon stock variability in sediments of southeastern Australia

Carolyn J. Ewers Lewis et al.

Correspondence to: Carolyn J. Ewers Lewis (ce8dp@virginia.edu)

Table S1. Hypothesized drivers of 30-cm deep sediment blue C stock variability. Potential drivers were identified in the literature, as described in the text and under "Hypothesis and rationale" of this table. These drivers were grouped into three categories: 1) ecological (ecosystem type and dominant species/ecological vegetation class), 2) geomorphological (elevation, slope, distance to freshwater channel, distance to coast, and lithology), and 3) anthropogenic (land use and population). Sources and resolution (where appropriate) for spatial data used as driver proxies in our modelling are described in the far right column.

Driver	Hypothesis and rationale	Spatial data source and resolution
Ecological		
ECOSYSTEM TYPE Tidal marsh, mangrove, or seagrass	Ecosystem is the dominant driver of C stock variability ➢ C stocks of tidal marshes > mangrove forests > seagrass meadows (Ewers Lewis et al., 2018; Siikamäki et al., 2013). ➢ C accumulation is driven by position in the tidal frame, therefore differs by ecosystem because each occupy a different inundation range in tidal frame (Saintilan et al., 2013). ➢ Differences in above- and below-ground plant biomass influence C stocks. Root C may be particularly important, as sediment C at depth in southeast Australian saltmarsh and mangrove has been observed to be dominated by root C and relatively low in allochthonous C, including leaf litter (Saintilan et al., 2013). ➢ Morphology impacts wave energy and particle settling (Mudd et al., 2010), as well as direct trapping by vegetation to the sediment surface (Chen et al., 2018).	Saltmarsh & mangrove extent: Boon et al., 2011 Seagrass extent: Blake et al., 2000; Blake and Ball, 2001b, 2001a; Roob et al., 1998; Roob and Ball, 1997
DOMINANT SPECIES/EVC Dominant species (seagrass, mangrove); Ecological Vegetation Class (tidal marshes)	Species composition better explains C stock variability than ecosystem alone ➢ C stocks vary across species (in seagrasses, e.g. Jankowska et al., 2016; Lavery et al., 2013; in tidal marsh plants, e.g. Sousa et al., 2010) and community composition (e.g. species richness in mangroves, Atwood et al. 2017). ➢ Species within a community occur at different elevations and positions in the tidal frame, which can impact sedimentation and C capture (e.g. Kelleway et al. 2017).	Saltmarsh EVC & mangrove extent: Boon et al., 2011 Seagrass extent: (Blake et al., 2000; Blake and Ball, 2001b, 2001a; Roob et al., 1998; Roob and Ball, 1997)
Geomorphological		
ELEVATION	Lower elevations are correlated with higher C stocks ➢ Lower elevations have higher sedimentation rates, aiding the trapping of organic C from organisms growing on soil surfaces (Connor et al., 2001). ➢ Lower elevations are inundated more often providing more opportunity for contribution of allochthonous C via particles and C settling out of the water column (Chen et al., 2015; Chmura et al., 2003; Chmura and Hung, 2004).	Victorian Coastal Digital Elevation Model (VCDEM 2017) 2.5 m and 10 m resolutions Cooperative Research Centre for Spatial Information (CRCSI)
SLOPE	Shallower slopes are correlated with higher C stocks ➢ Steeper slopes are more vulnerable to erosion and less conducive to sedimentation and particle trapping than shallower slopes.	Calculated in ArcMap from 2.5 m and 10 m elevation data (above)

DISTANCE TO FRESHWATER CHANNEL Euclidean distance to closest channel	Distance to freshwater channel is negatively correlated with C stocks ➢ Sediment accretion rates (positively correlated to organic matter) decrease with distance from freshwater channels as elevation increases and inundation is less frequent (Chmura and Hung, 2004). ➢ Higher freshwater inputs may lead to higher production of autochthonous C (Kelleway et al., 2016). ➢ Delivery of nutrients from terrestrial sources may increase plant growth (Armitage and Fourqurean, 2016). ➢ Fluvial environments are associated with smaller grain size particles, which enhance C preservation compared to sandy substrates (Kelleway et al., 2016; Saintilan et al., 2013).	Vicmap Hydro 1:25,000 Department of Environment, Land, Water & Planning Victoria State Government
DISTANCE TO COAST Euclidean distance to closest point on the coast	C stocks are greater higher up in the catchment ➢ C stocks in fluvial environments > marine environments (e.g. in tidal marshes, Van De Broek et al., 2016; Kelleway et al., 2016; Macreadie et al., 2017a; Saintilan et al., 2013). ➢ Fluvially located tidal marshes have on average over 2x higher C stocks compared to marine tidal marshes (Kelleway et al., 2017; Macreadie et al., 2017a). ➢ Greater inputs of suspended particulate organic C from terrestrial sources higher in the catchment (Van De Broek et al., 2016). ➢ Amount of deeper, stable C in tidal marshes decreased from the upper estuary toward the coast (Van De Broek et al., 2016).	Victorian Coastline 2008 Department of Environment, Land, Water & Planning Victoria State Government
LITHOLOGY Rock type that covers the greatest proportion of the catchment	C stocks vary with terrestrial parent material of sediments ➢ Terrestrial weathering, erosion, and sediment properties influence organic C export (Galy et al., 2007) ➢ Rock type may influence grain size of sediments exported from catchments; smaller grain sizes enhance C preservation (Kelleway et al., 2016; Saintilan et al., 2013), bind more organic molecules relative to coarse particles (Mayer, 1994), and can be associated with high C stocks (e.g. Serrano et al. 2016) ➢ Mineral content affects organic C quantity, preservation, and flux (Torn et al., 1997).	Geomorphology of Victoria 1:100,000 Department of Economic Development, Jobs, Transport and Resources Victoria State Government
Anthropogenic		
LAND USE Represented as proportion of catchment area that primary land use is 1) urbanized 2) agricultural 3) natural	C stocks vary based on land use activities in the catchment ➢ Land use may impact export of terrestrial C contributing to allochthonous C inputs to blue C ecosystems; allochthonous C can contribute up to 50% of C stocks (e.g. in seagrasses, Kennedy et al. 2010). ➢ Nutrient inputs (e.g. from sewage effluent and agricultural runoff) can increase productivity, but have a negative impact on net C stocks (Armitage and Fourqurean, 2016; Kearns et al., 2018; Macreadie et al., 2017b). ➢ Erosion of fine sediments in urbanized and agricultural regions may enhance sedimentation and C burial (Mazarrasa et al., 2017; Serrano et al., 2016b; Yang et al., 2003).	Victorian Land Use Information System 2014/2015 Department of Economic Development, Jobs, Transport and Resources Victoria State Government

POPULATION Mean population density of the catchment	C stocks differ across population levels due to a correlation with land use ➢ Increases in population size lead to increases in urbanisation and competition for land use.	Population Density, Australia 2011 Australian Bureau of Statistics

Table S2. Lithologies in Victoria

Raster Code	Lithology
0	other
1	Aeolian
2	Aeolian and Alluvium
3	Alluvial
4	Alluvium
5	Basalt
6	Colluvial
7	Duricrust
8	Fluvial
9	Fluvial Aeolian
10	Granite
11	Granitic
12	Lacustrine/Aeolian
13	Lagoonal
14	Limestone
15	Marl
16	Metamorphic
17	Paleozoic sediments
18	Sedimentary
19	Tertiary basalts
20	Volcanic

Table S3. Primary Land Use Categories

Land Use Code	Description	Details	Category for Land Use Proxy
1	Residential	Housing	Urbanized
2	Commercial	Shops, restaurants, cinemas, amusement parks, bars, hospitals, offices, parking lots	Urbanized
3	Industrial	Manufacturing, warehouses, noxious/dangerous production (e.g. tannery, oil refinery)	Urbanized
4	Extractive Industries	Mining (sand, rock, metals, salt, water, dredging)	Urbanized
5	Primary Production	Native, grazing, ag, farming, orchards, forestry, aquaculture	Agricultural
6	Infrastructure and utilities	Gas, electricity, waste, recycling, water, roads, railways, tramways, wharfs, post	Urbanized
7	Community services	Schools, day-care, hospitals, police, courts, emergency services, prisons, churches, sporting halls, government buildings and bases	Urbanized
8	Sport Heritage and Culture	Sports complexes, race tracks, fields, libraries, museums, botanical gardens, aquariums, memorials	Urbanized
9	National parks, conservation areas, forest reserves, and natural water reserves	Reserves, wetlands, national parks, protected areas	Natural

Table S4. Covariates included in the twelve global models for 30-cm deep sediment blue C stocks. To avoid correlation between covariates, each model contained six fixed covariates and site as a random effect. EVC = ecological vegetation class (for tidal marsh); D = distance; FW = freshwater channel; population = mean population; % = proportion of the catchment area of the named land use.

GLOBAL MODEL	FIXED EFFECTS											RANDOM EFFECT
	Ecological Covariates			Geomorphological Covariates				Anthropogenic Covariates				
1	Ecosystem			Slope	D to Coast	D to FW	Lithology	Population				Site
2		Dominant Species or EVC		Slope	D to Coast	D to FW	Lithology	Population				Site
3			Elevation	Slope	D to Coast	D to FW	Lithology	Population				Site
4	Ecosystem			Slope	D to Coast	D to FW	Lithology		% Urbanized			Site
5		Dominant Species or EVC		Slope	D to Coast	D to FW	Lithology		% Urbanized			Site
6			Elevation	Slope	D to Coast	D to FW	Lithology		% Urbanized			Site
7	Ecosystem			Slope	D to Coast	D to FW	Lithology			% Agricultural		Site
8		Dominant Species or EVC		Slope	D to Coast	D to FW	Lithology			% Agricultural		Site
9			Elevation	Slope	D to Coast	D to FW	Lithology			% Agricultural		Site
10	Ecosystem			Slope	D to Coast	D to FW	Lithology				% Natural	Site
11		Dominant Species or EVC		Slope	D to Coast	D to FW	Lithology				% Natural	Site
12			Elevation	Slope	D to Coast	D to FW	Lithology				% Natural	Site

Table S5. AIC_C ranking of the twelve global models for 30-cm deep sediment blue C stocks.

Global Model	K	AIC_C	Delta_AIC_C	AIC_CWt	Cum.Wt	LL
11	30	1823.61	0.00	0.70	0.70	-876.27
5	30	1826.39	2.79	0.17	0.87	-877.66
2	30	1828.21	4.60	0.07	0.94	-878.57
8	30	1828.65	5.04	0.06	1.00	-878.79
10	24	1858.48	34.87	0.00	1.00	-876.27
4	24	1860.99	37.38	0.00	1.00	-903.05
1	24	1864.31	40.71	0.00	1.00	-904.71
7	24	1864.75	41.14	0.00	1.00	-904.93
12	23	1886.26	62.65	0.00	1.00	-916.98
6	23	1893.33	69.72	0.00	1.00	-920.51
9	23	1895.62	72.01	0.00	1.00	-921.66
3	23	1895.97	72.37	0.00	1.00	-921.83

Table S6. Dredge products of dominant species/EVC global models. Top models resulting from dredging the global models (based on delta $AIC_C<2$) were used to produce averaged models and parameter estimates. Note the anthropogenic covariate distinguishes the global models from one another. EVC = ecological vegetation class; *N/A* = parameter was not included in the dredge product model; "+" = factor included in model.

Global Model	Dredge product	Intercept	Distance to coast	Dominant species/EVC	Primary lithology	Distance to freshwater	Slope	Proportion natural	df	logLik	AICc	delta	weight
11	3	0.0168564	*NA*	+	*NA*	*NA*	*NA*	*NA*	11	-895.369	1814.15	0	1.29E-01
	4	0.0189982	-0.0020353	+	*NA*	*NA*	*NA*	*NA*	12	-894.3325	1814.342	0.1926387	1.17E-01
	12	0.018197	-0.0022854	+	*NA*	-0.0025109	*NA*	*NA*	13	-893.5455	1815.059	0.9088236	8.17E-02
	36	0.0189583	-0.0023732	+	*NA*	*NA*	*NA*	0.001781	13	-893.6158	1815.199	1.0493365	7.61E-02
	11	0.0157893	*NA*	+	*NA*	-0.0019917	*NA*	*NA*	12	-894.8916	1815.461	1.31077	6.68E-02
	19	0.0166106	*NA*	+	*NA*	*NA*	-6.83E-04	*NA*	12	-894.9389	1815.555	1.4055444	6.37E-02
	20	0.0190315	-0.0021158	+	*NA*	*NA*	-7.06E-04	*NA*	13	-893.8551	1815.678	1.5279401	5.99E-02
	35	0.0164176	*NA*	+	*NA*	*NA*	*NA*	0.0012525	12	-895.0034	1815.684	1.534444	5.97E-02

Global Model	Dredge product	Intercept	Distance to coast	Dominant species/EVC	Primary lithology	Distance to freshwater	Slope	Proportion urbanized	df	logLik	AICc	delta	weight
5	3	0.01685643	*NA*	+	*NA*	*NA*	*NA*	*NA*	11	-895.3690	1814.150	0.0000000	1.113112e-01
	4	0.01899821	-0.0020353223	+	*NA*	*NA*	*NA*	*NA*	12	-894.3325	1814.342	0.1926387	1.010899e-01
	36	0.01800898	-0.0019729499	+	*NA*	*NA*	*NA*	-0.0021066956	13	-893.2183	1814.404	0.2543995	9.801593e-02
	35	0.01551172	*NA*	+	*NA*	*NA*	*NA*	-0.0019051529	12	-894.3987	1814.475	0.3251377	9.460978e-02
	12	0.01819697	-0.0022853901	+	*NA*	-0.002510929	*NA*	*NA*	13	-893.5455	1815.059	0.9088236	7.066271e-02
	44	0.01711336	-0.0023424427	+	*NA*	-0.002368407	*NA*	-0.0020726030	14	-892.4650	1815.213	1.0628511	6.542498e-02
	11	0.01578925	*NA*	+	*NA*	-0.001991729	*NA*	*NA*	12	-894.8916	1815.461	1.3107700	5.779746e-02
	19	0.01661063	*NA*	+	*NA*	*NA*	-0.0006827148	*NA*	12	-894.9389	1815.555	1.4055444	5.512248e-02
	20	0.01903147	-0.0021157993	+	*NA*	*NA*	-0.0007056025	*NA*	13	-893.8551	1815.678	1.5279401	5.185025e-02
	43	0.01470687	*NA*	+	*NA*	-0.002029556	*NA*	-0.0019050897	13	-893.9474	1815.862	1.7126661	4.727571e-02
	52	0.01798426	-0.0021412230	+	*NA*	*NA*	-0.0006979693	-0.0020573538	14	-892.7948	1815.872	1.7225099	4.704360e-02
	51	0.01478040	*NA*	+	*NA*	*NA*	-0.0005631329	-0.0021105856	13	-894.0431	1816.054	1.9040556	4.296140e-02

Global Model	Dredge product	Intercept	Distance to coast	Dominant species/EVC	Primary lithology	Distance to freshwater	Slope	Mean Population Density	df	logLik	AICc	delta	weight
2	3	0.01685643	*NA*	+	*NA*	*NA*	*NA*	*NA*	11	-895.3690	1814.150	0.0000000	1.543957e-01
	4	0.01899821	-0.0020353223	+	*NA*	*NA*	*NA*	*NA*	12	-894.3325	1814.342	0.1926387	1.402182e-01
	12	0.01819697	-0.0022853901	+	*NA*	-0.002510929	*NA*	*NA*	13	-893.5455	1815.059	0.9088236	9.801370e-02
	11	0.01578925	*NA*	+	*NA*	-0.001991729	*NA*	*NA*	12	-894.8916	1815.461	1.3107700	8.016877e-02
	35	0.01661063	*NA*	+	*NA*	*NA*	-0.0006827148	*NA*	12	-894.9389	1815.555	1.4055444	7.645840e-02
	36	0.01903147	-0.0021157993	+	*NA*	*NA*	-0.0007056025	*NA*	13	-893.8551	1815.678	1.5279401	7.191961e-02

Global Model	Dredge product	Intercept	Distance to coast	Dominant species/EVC	Primary lithology	Distance to freshwater	Slope	Proportion agricultural	df	logLik	AICc	delta	weight
8	3	0.01685643	*NA*	+	*NA*	*NA*	*NA*	*NA*	11	-895.3690	1814.150	0.0000000	1.581714e-01
	4	0.01899821	-0.0020353223	+	*NA*	*NA*	*NA*	*NA*	12	-894.3325	1814.342	0.1926387	1.436472e-01
	12	0.01819697	-0.0022853901	+	*NA*	-0.002510929	*NA*	*NA*	13	-893.5455	1815.059	0.9088236	1.004106e-01

11	0.01578925	NA	+	NA	-0.001991729	NA	NA	12	-894.8916	1815.461	1.3107700	8.212926e-02
19	0.01661063	NA	+	NA	NA	-0.0006827148	NA	12	-894.9389	1815.555	1.4055444	7.832816e-02
20	0.01903147	-0.0021157993	+	NA	NA	-0.0007056025	NA	13	-893.8551	1815.678	1.5279401	7.367837e-02

Table S7. Full output table of averaged model parameter estimates containing dominant species/ecological vegetation class (EVC) as the ecological variable.

Averaged model 11

Parameter	Estimate	Adjusted SE	Confidence interval		Relative importance	N containing models
			2.5%	97.5%		
Intercept: Coastal tussock saltmarsh	0.0177	0.0043	0.0093	0.0260		
Factor (dominant sp/EVC): Wet saltmarsh herbland	0.0012	0.0041	-0.0068	0.0092	1.00	8
Factor (dominant sp/EVC): wet saltmarsh shrubland	-0.0027	0.0042	-0.0110	0.0056	"	"
Factor (dominant sp/EVC): *A. marina* mangroves	0.0011	0.0041	-0.0070	0.0092	"	"
Factor (dominant sp/EVC): *L. marina* seagrass	-0.0024	0.0051	-0.0123	0.0075	"	"
Factor (dominant sp/EVC): *P. australis* seagrass	0.0394	0.0179	0.0043	0.0745	"	"
Factor (dominant sp/EVC): *R. megacarpa* seagrass	0.0903	0.0313	0.0289	0.1518	"	"
Factor (dominant sp/EVC): *Z. muelleri* seagrass	0.0291	0.0047	0.0198	0.0384	"	"
Factor (dominant sp/EVC): *Z. nigricaulis* seagrass	0.0397	0.0172	0.0060	0.0735	"	"
Distance to coast	-0.0011	0.0015	-0.0041	0.0019	0.51	4
Distance to freshwater	-0.0005	0.0014	-0.0032	0.0022	0.23	2
Proportion natural	0.0003	0.0009	-0.0015	0.0022	0.21	2
Slope	-0.0001	0.0004	-0.0015	0.0022	0.19	2

Averaged model 5

Parameter	Estimate	Adjusted SE	Confidence interval		Relative importance	N containing models
			2.5%	97.5%		
Intercept: Coastal tussock saltmarsh	0.0171	0.0042	0.0088	0.0254		
Factor (dominant sp/EVC): Wet saltmarsh herbland	0.0013	0.0040	-0.0066	0.0092	1.00	12
Factor (dominant sp/EVC): wet saltmarsh shrubland	-0.0023	0.0042	-0.0107	0.0060	"	"
Factor (dominant sp/EVC): *A. marina* mangroves	0.0015	0.0041	-0.0066	0.0095	"	"
Factor (dominant sp/EVC): *L. marina* seagrass	-0.0020	0.0051	-0.0119	0.0080	"	"
Factor (dominant sp/EVC): *P. australis* seagrass	0.0405	0.0179	0.0054	0.0756	"	"
Factor (dominant sp/EVC): *R. megacarpa* seagrass	0.0908	0.0314	0.0293	0.1523	"	"
Factor (dominant sp/EVC): *Z. muelleri* seagrass	0.0295	0.0047	0.0202	0.0388	"	"
Factor (dominant sp/EVC): *Z. nigricaulis* seagrass	0.0389	0.0172	0.0052	0.0727	"	"
Distance to coast	-0.0011	0.0015	-0.0040	0.0018	0.51	6

Proportion Urbanized	-0.0010	0.0014	-0.0037	0.0018	0.47	6
Distance to freshwater	-0.0006	0.0015	-0.0036	0.0023	0.29	4
Slope	-0.0002	0.0005	-0.0010	0.0007	0.23	4

Averaged model 2

Parameter	Estimate	Adjusted SE	Confidence interval		Relative importance	N containing models
			2.5%	97.5%		
Intercept: Coastal tussock saltmarsh	0.0176	0.0042	0.0093	0.0260		
Factor (dominant sp/EVC): Wet saltmarsh herbland	0.0011	0.0041	-0.0069	0.0091	1.00	6
Factor (dominant sp/EVC): wet saltmarsh shrubland	-0.0028	0.0042	-0.0111	0.0055	"	"
Factor (dominant sp/EVC): *A. marina* mangroves	0.0011	0.0041	-0.0070	0.0092	"	"
Factor (dominant sp/EVC): *L. marina* seagrass	-0.0024	0.0051	-0.0124	0.0075	"	"
Factor (dominant sp/EVC): *P. australis* seagrass	0.0412	0.0180	0.0058	0.0765	"	"
Factor (dominant sp/EVC): *R. megacarpa* seagrass	0.0909	0.0313	0.0296	0.1522	"	"
Factor (dominant sp/EVC): *Z. muelleri* seagrass	0.0292	0.0047	0.0199	0.0385	"	"
Factor (dominant sp/EVC): *Z. nigricaulis* seagrass	0.0398	0.0172	0.0060	0.0736	"	"
Distance to coast	-0.0011	0.0015	-0.0040	0.0019	0.50	3
Distance to freshwater	-0.0007	0.0015	-0.0036	0.0023	0.29	2
Slope	-0.0002	0.0005	-0.0011	0.0007	0.24	2

Table S8. Dredge products of ecosystem global models. Top models resulting from dredging the global models (based on delta AIC_C <2) were used to produce averaged models and parameter estimates. Note the anthropogenic covariate distinguishes the global models from one another. *N/A* = parameter was not included in the dredge product model; "+" = factor included in model.

Global Model	Dredge product	Intercept	Distance to coast	Ecosystem	Primary lithology	Distance to freshwater	Slope	Proportion natural	df	logLik	AICc	delta	weight
10	36	0.0181	-0.0020	+	NA	NA	NA	0.0029	7	-916.37	1847.33	0.00	0.1583
	35	0.0177	NA	+	NA	NA	NA	0.0023	6	-917.61	1847.66	0.32	0.1346
	3	0.0174	NA	+	NA	NA	NA	NA	5	-918.96	1848.23	0.90	0.1007
	52	0.0180	-0.0021	+	NA	NA	-0.0009	0.0030	8	-915.79	1848.34	1.01	0.0953
	51	0.0177	NA	+	NA	NA	-0.0008	0.0023	7	-917.15	1848.88	1.55	0.0730

Global Model	Dredge product	Intercept	Distance to coast	Ecosystem	Primary lithology	Distance to freshwater	Slope	Proportion urbanized	df	logLik	AICc	delta	weight
4	35	0.0165	NA	+	NA	NA	NA	-0.0027	6	-916.94	1846.31	0.00	0.2036
	36	0.0166	-0.0014	+	NA	NA	NA	-0.0029	7	-916.09	1846.77	0.46	0.1615
	51	0.0165	NA	+	NA	NA	-0.0006	-0.0026	7	-916.60	1847.79	1.48	0.0969
	52	0.0165	-0.0015	+	NA	NA	-0.0007	-0.0029	8	-915.70	1848.15	1.84	0.0810
	3	0.0174	NA	+	NA	NA	NA	NA	5	-918.96	1848.23	1.93	0.0778

Global Model	Dredge product	Intercept	Distance to coast	Ecosystem	Primary lithology	Distance to freshwater	Slope	Mean Population Density	df	logLik	AICc	delta	weight
1	3	0.0174	NA	+	NA	NA	NA	NA	5	-918.96	1848.23	0.00	0.2036
	4	0.0175	-0.0012	+	NA	NA	NA	NA	6	-918.45	1849.35	1.11	0.1168
	35	0.0173	NA	+	NA	NA	-0.0008	NA	6	-918.50	1849.44	1.21	0.1113
	19	0.0172	NA	+	NA	NA	NA	-0.0005	6	-918.67	1849.78	1.54	0.0943

Global Model	Dredge product	Intercept	Distance to coast	Ecosystem	Primary lithology	Distance to freshwater	Slope	Proportion agricultural	df	logLik	AICc	delta	weight
7	3	0.0174	NA	+	NA	NA	NA	NA	5	-918.96	1848.23	0.00	0.2181
	4	0.0175	-0.0012	+	NA	NA	NA	NA	6	-918.45	1849.35	1.11	0.1251
	19	0.0173	NA	+	NA	NA	-0.0008	NA	6	-918.50	1849.44	1.21	0.1192

Table S9. Full output table of averaged model parameter estimates containing ecosystem as the ecological variable.

Averaged model 10

Parameter	Estimate	Adjusted SE	Confidence interval 2.5%	Confidence interval 97.5%	Relative importance	N containing models
Intercept: tidal marsh	0.0178	0.0020	0.0139	0.0217		
factor(Ecosystem): mangrove	0.0022	0.0013	-0.0002	0.0047	1.00	5
factor(Ecosystem): seagrass	0.0244	0.0026	0.0193	0.0294	"	"
Distance to coast	-0.0009	0.0014	-0.0036	0.0017	0.45	2
Slope	-0.0002	0.0006	-0.0014	0.0009	0.30	2
Proportion natural	0.0022	0.0017	-0.0011	0.0055	0.82	4

Averaged model 4

Parameter	Estimate	Adjusted SE	Confidence interval 2.5%	Confidence interval 97.5%	Relative importance	N containing models
Intercept: tidal marsh	0.0166	0.0018	0.0130	0.0202		
factor(Ecosystem): mangrove	0.0024	0.0013	-0.0001	0.0049	1.00	5
factor(Ecosystem): seagrass	0.0254	0.0025	0.0204	0.0303	"	"
Distance to coast	-0.0006	0.0010	-0.0025	0.0014	0.39	2
Slope	-0.0002	0.0005	-0.0012	0.0008	0.29	2
Proportion urbanized	-0.0024	0.0015	-0.0054	0.0006	0.87	4

Averaged model 1

Parameter	Estimate	Adjusted SE	Confidence interval 2.5%	Confidence interval 97.5%	Relative importance	N containing models
Intercept: tidal marsh	0.0174	0.0020	0.0135	0.0212		
factor(Ecosystem): mangrove	0.0022	0.0013	-0.0003	0.0047	1.00	4
factor(Ecosystem): seagrass	0.0252	0.0025	0.0202	0.0301	"	"
Distance to coast	-0.0003	0.0008	-0.0018	0.0012	0.22	1
Slope	-0.0002	0.0005	-0.0011	0.0008	0.21	1
Mean population density	-0.0001	0.0004	-0.0008	0.0006	0.18	1

Averaged model 7						
			Confidence interval			
Parameter	**Estimate**	**Adjusted SE**	**2.5%**	**97.5%**	**Relative importance**	**N containing models**
Intercept (tidal marsh)	0.0174	0.0020	0.0136	0.0213		
factor(Ecosystem): mangrove	0.0022	0.0013	-0.0003	0.0047	1.00	3
factor(Ecosystem): seagrass	0.0252	0.0025	0.0202	0.0301	"	"
Distance to coast	-0.0003	0.0008	-0.0020	0.0013	0.27	1
Slope	-0.0002	0.0005	-0.0012	0.0008	0.26	1

Table S10. Data availability

Data Item	Description	Data Source & Location
Carbon Stock Dataset	Percent organic carbon and dry bulk density data for sediment sampled to 30 cm deep in 96 blue carbon ecosystems (saltmarshes, mangrove forests, and seagrass meadows) across Victoria, Australia.	Ewers Lewis et al. 2018 *Ecosystems*; Dataset available on Harvard Dataverse, https://doi.org/10.7910/DVN/6PFBO0
Ecosystem Extent Vectors	1. Mangrove areal extent in Victoria, Australia; saltmarsh areal extent and ecological vegetation classes in Victoria, Australia. 2. Seagrass areal extent in the major bays and estuaries of Victoria, Australia. a. Port Phillip Bay b. Western Port Bay c. Corner Inlet and Nooramunga d. Gippsland Lakes e. Minor Inlets of Victoria	1. Boon et al. 2001; OzCoasts Australian Online Coastal Information, Victorian Saltmarsh and Mangrove Vegetation Maps https://ozcoasts.org.au/geom_geol/vic/Saltmarsh/Master 2. Available from: a. Ball et al., 2014; Blake and Ball, 2001a https://discover.data.vic.gov.au/dataset/port-phillip-bay-1-25-000-seagrass-2000 b. Blake and Ball, 2001b Distribution of Seagrass in Western Port in 1999 https://discover.data.vic.gov.au/dataset/distribution-of-seagrass-in-western-port-in-1999 c. Roob et al., 1998 Corner Inlet Seagrass 1998 https://discover.data.vic.gov.au/dataset/corner-inlet-seagrass-1998 d. (Roob and Ball, 1997) Gippsland Lakes Seagrass 1997 https://discover.data.vic.gov.au/dataset/gippsland-lakes-seagrass-1997 e. Blake et al., 2000 Anderson Inlet Seagrass 1999 https://discover.data.vic.gov.au/dataset/anderson-inlet-seagrass-1999 Tamboon Inlet Seagrass 1999 https://discover.data.vic.gov.au/dataset/tamboon-inlet-seagrass-1999 Wingan Inlet Seagrass 1999 https://discover.data.vic.gov.au/dataset/wingan-inlet-seagrass-1999 Shallow Inlet Seagrass 1999 https://discover.data.vic.gov.au/dataset/shallow-inlet-seagrass-1999 Mallacoota Inlet Seagrass 1999 https://discover.data.vic.gov.au/dataset/mallacoota-inlet-seagrass-1999 Sydenham Inlet Seagrass 1999 https://discover.data.vic.gov.au/dataset/sydenham-inlet-seagrass-1999
Elevation Raster	A gap free digital elevation model (DEM) for the coastal region of Victoria, Australia, that combines 2.5 m and 10 m DEMs.	Victorian Coastal Digital Elevation Model (VCDEM 2017) https://vmdp.deakin.edu.au/geonetwork/srv/eng/metadata.show?uuid=8d3ccf63-ee85-41cd-917e-933624a50b2e
Freshwater Vectors	Location of channels and other freshwater objects in Victoria, Australia.	Vicmap Hydro 1:25,000 Victorian Government Data portal https://discover.data.vic.gov.au/dataset/vicmap-hydro-1-25-000

Coastline Vector	Line delineating the coastline of Victoria, Australia.	Victorian Coastline 2008 Victorian Government Data portal https://discover.data.vic.gov.au/dataset/victorian-coastline-2008
Lithology Vectors	Rock types across Victoria, Australia.	Geomorphology of Victoria Victorian Government Data portal https://discover.data.vic.gov.au/dataset/geomorphology-of-victoria
Land Use Vectors	Primary land use designations for land parcels in Victoria, Australia.	Victorian Land Use Information System 2014/2015 Victorian Government Data portal https://discover.data.vic.gov.au/dataset/victorian-land-use-information-system-2014-2015
Population Raster	Human population data for Victoria, Australia.	Australian Population Grid, 2011 Australian Bureau of Statistics https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1270.0.55.007Main+Features12011?OpenDocument
R Code	R code used to identify drivers and model carbon shallow sediment carbon stocks.	This study. Dataset available on Harvard Dataverse, https://doi.org/10.7910/DVN/0WKEHJ
Model Output Raster	Shallow sediment (to 30 cm deep) carbon stock predictions in blue carbon ecosystems (seagrass meadows, mangrove forests, and saltmarshes) in Victoria, Australia	This study. Dataset available on Harvard Dataverse, https://doi.org/10.7910/DVN/UDOAUT

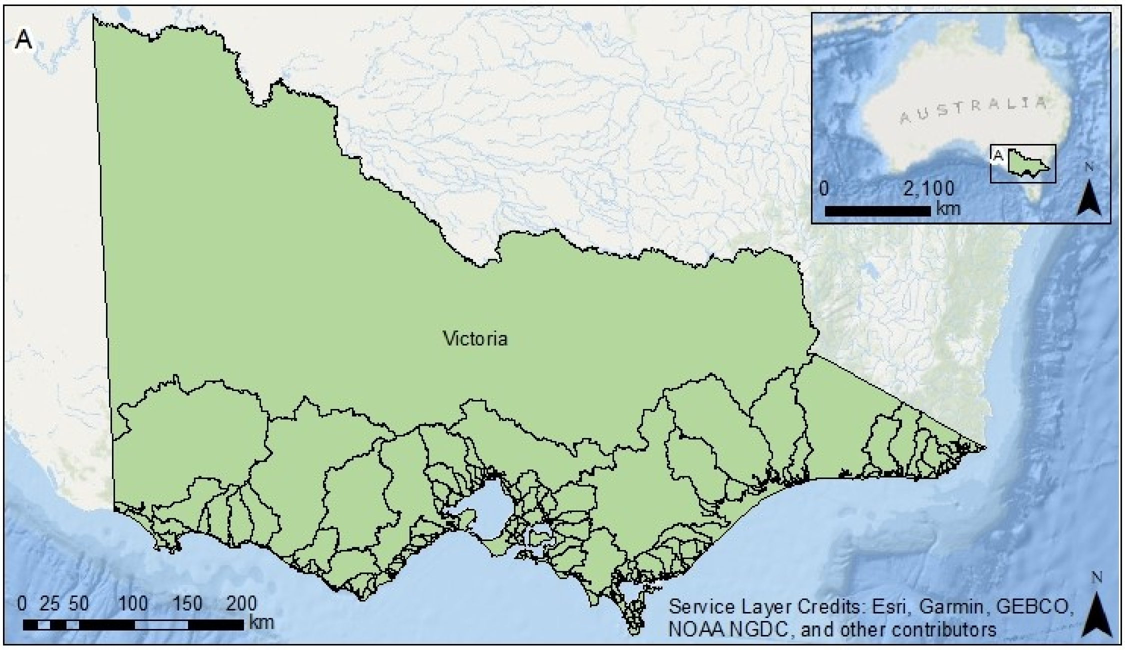

Figure S1. Fluvial and estuarine catchment regions for Victoria, Australia (Barton et al., 2008).

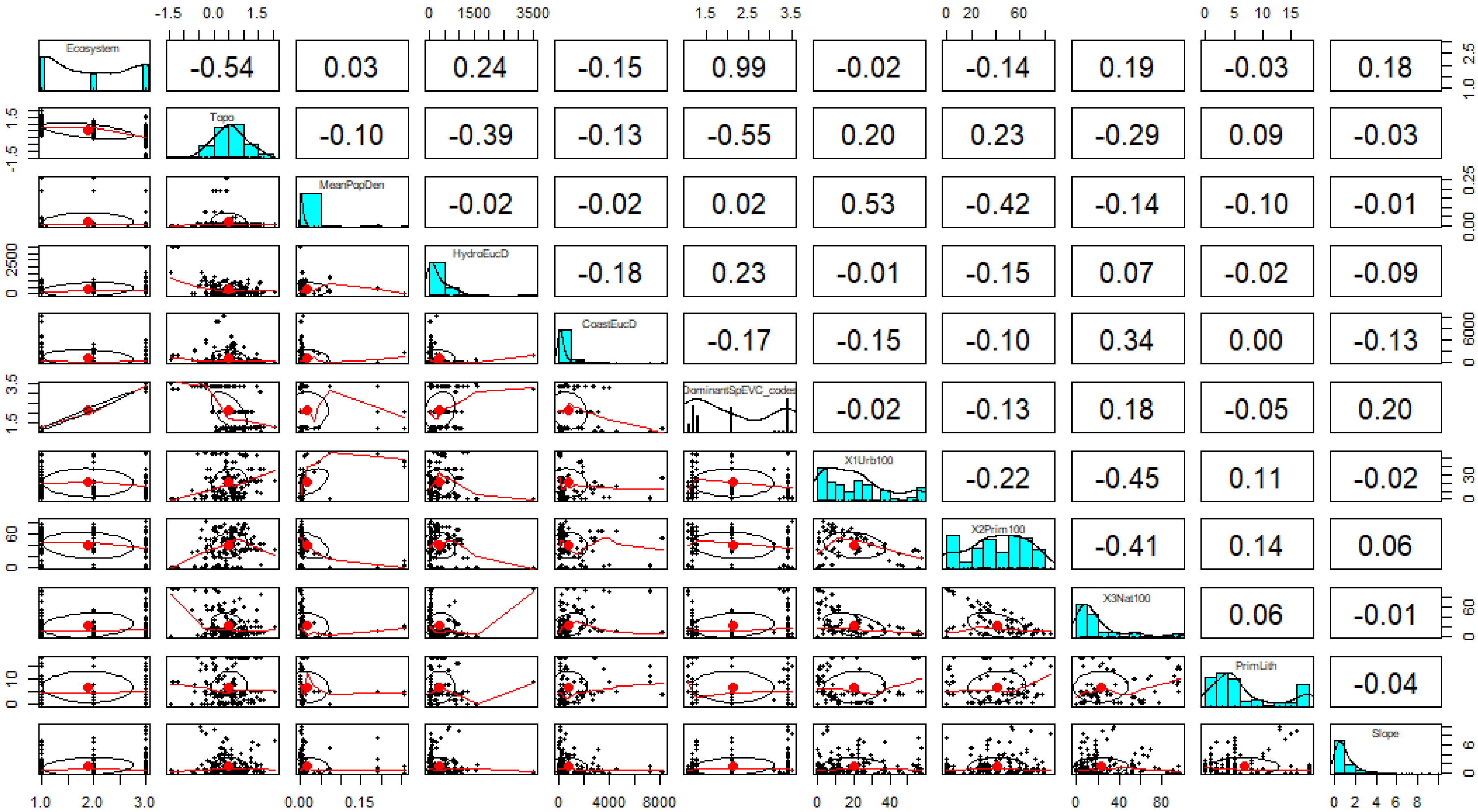

Figure S2. Pairwise plots showing correlation relationships between covariates. From top left to bottom right: ecosystem type, elevation ("topo"), mean population density ("MeanPopDen"), distance to freshwater channel ("HydroEucD"), distance to coast ("CoastEucD"), dominant species/ecological vegetation class ("DominantSpEVC_codes"), proportion urbanized ("X1Urb100"), proportion agricultural ("X2Prim100"), proportion natural ("X3Nat100"), primary lithology ("PrimLith"), and slope.

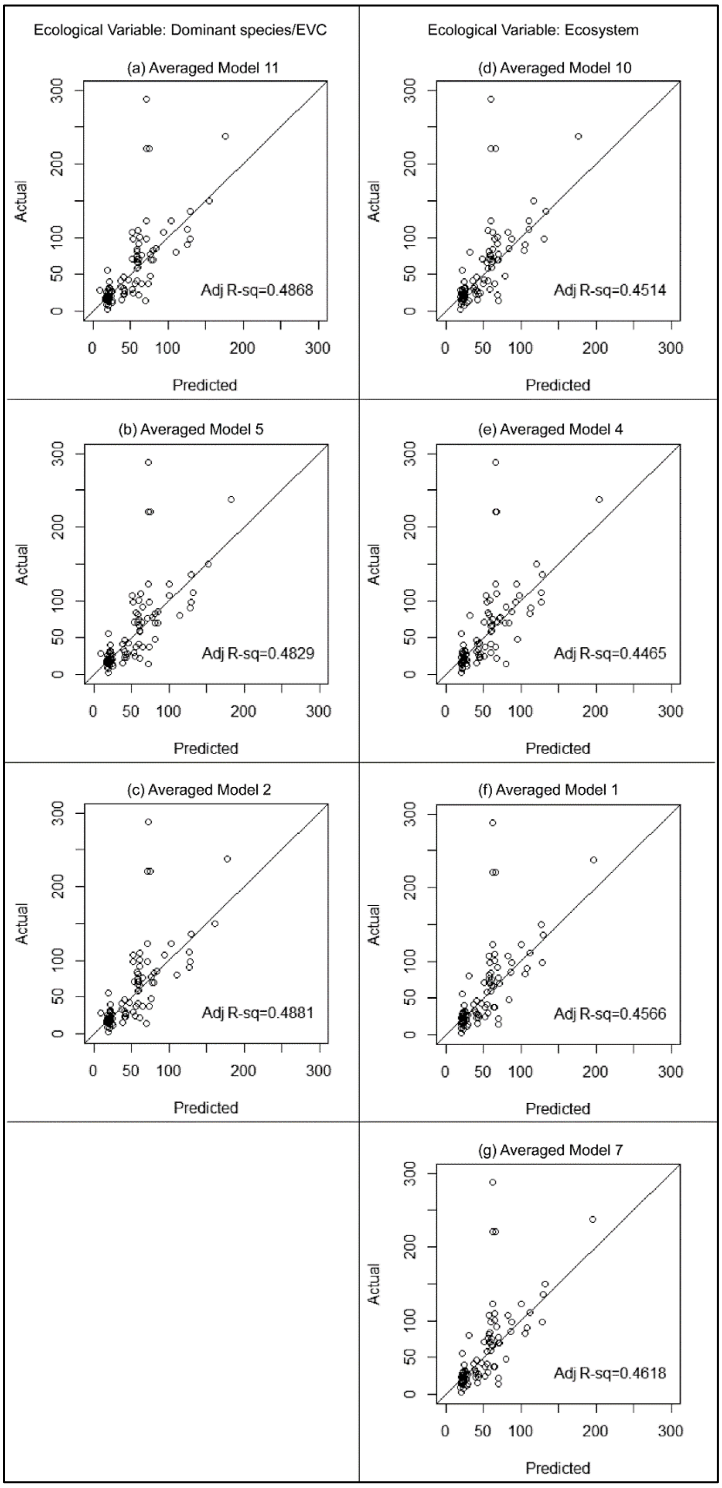

Figure S3. Predicted v. actual 30-cm deep sediment blue C stocks. Averaged model 2 produced the best predictions out of the models using dominant species/EVC as the ecological variable (left column), while averaged model 7 produced the best predictions out of the models using ecosystem as the ecological variable. Neither of the best averaged models (2 and 7) included anthropogenic covariates. Linear regressions of predicted versus actual measured 30-cm deep sediment C values produced the following outputs for each averaged model: averaged model 11, residual standard error (RSE)=38.36 on 84 degrees of freedom (df), adjusted R-squared (R-sq(adj))=0.4868, F-statistic(F-stat)=81.63 on 1 and 84 df, p-value=5.044e-14; averaged model 5, RSE=38.51, R-sq(adj)=0.4829, F-stat=80.39 on 1 and 84 df, p-value=6.953e-14; averaged model 2, RSE=38.32, R-sq(adj)=0.4881, F-stat=82.06 on 1 and 84 df, p-value=4.517e-14; averaged model 10, RSE=39.67, R-sq(adj)=0.4514, F-stat=70.93 on 1 and 84 df, p-value=8.645e-13; averaged model 4, RSE=39.84, R-sq(adj)=0.4465, F-stat=69.58 on 1 and 84 df, p-value=1.254e-12; averaged model 1; RSE=39.48, R-sq(adj)=0.4566, F-stat=72.43 on 1 and 84 df, p-value=5.73e-13; averaged model 7, RSE=39.29, R-sq(adj)=0.4618, F-stat=73.94 on 1 and 84 df, p-value=3.81e-13.