

Supplementary Tables**Table S1.** Cormorant colonies included in this study. ARC=Archipelago Sea, BOTB=Bothnian Bay, BOTS=Bothnian Sea, EGF=Eastern Gulf of Finland, KVA=Kvarken, WGF=Western Gulf of Finland. Years active = when cormorants nested on the island. Sampling years = when sampling was conducted.

Colony Name	Area (ha)	Geogr area	Points within 5 km	Active years	Sampling years	Pop'n (breeding pairs) during sampling years
Ådgrundet	1.56	WGF	76	2002-2011	2009, 2011	109, 12
Äggharuna	2.42	WGF	1161	2002-2014	2009-2013	204, 248, 286, 213, 262
Äggskär	0.3	ARC	67	2003-2017	2010, 2013-2015	1436, 952, 690, 416
Äjäkari	0.31	ARC	75	2010-	2011, 2014-2015	19, 79, 551
Äjänkumpele	0.3	BOTB	64	2009-	2011-2013	27, 47, 63
Bådan	0.46	ARC	30	2012-2017	2012, 2014	50, 92
Bisaballen	5.01	EGF	124	2006-	2012-2015	828, 749, 981, 835
Eistinkari	0.25	EGF	342	2011-2015	2012-2015	156, 224, 797, 101
Fågelgrund	0.43	KVA	129	2007-	2013	921
Fjärdgrundet	1.78	KVA	135	2003-	2013-2014	183, 468
Gaddit	1.83	WGF	214	2005-	2012-2015	468, 741, 879, 865
Iso Haahkaluoto	3.88	WGF	160	2002-	2012-2015	85, 1739, 1899, 1571
Iso Mustiletto	0.46	ARC	81	2009-2014	2009, 2013	29, 189
Järvikari	0.69	BOTS	213	2005-	2013-2015	771, 267, 158
Kalmanhohde	0.18	ARC	8	2009-2011	2009	342
Kirveskari	1.08	ARC	25	2011, 2013-2014, 2016	2011	160
Kivikartti	0.78	EGF	10	2004-2007, 2009-	2012	115
Kluppi	5.18	ARC	49	2003-2013	2013	70
Kumpelkari	0.64	ARC	64	2012-2014	2013	477
Laurinkari	1.25	EGF	633	2001-2005, 2007-	2009-2010, 2012-2015	52, 108, 152, 192, 285, 240
Leppäkari	1.06	BOTS	115	2002-2015	2013-2015	2647, 3013, 4119
Lerharun	2.53	WGF	42	1996-2010	2009	252
Majsgrundet	0.28	KVA	163	2012-	2013, 2014	181, 314
Marjakari	1.93	BOTS	191	2003-	2011, 2013-2015	1084, 1581, 1030, 1768
Måsgrund	0.3	ARC	109	2009-2016	2009, 2011, 2012-2013, 2015	186, 520, 760, 755, 440
Måskobben	0.56	ARC	106	2007-2011	2010	210
Nätiskarven	1.73	EGF	145	2008-	2012-2015	691, 791, 698, 577
Pohjanletto	1.04	BOTB	1024	2000-	2009-2015	240, 192, 131, 131, 130, 98, 106
Puskakari	3.64	BOTS	2107	2005-	2009-2012, 2014	1176, 966, 2342, 996, 989
Röngrundet	1.52	ARC	408	2003-	2010-2012, 2015	398, 483, 160, 140
Ryslät	5.26	EGF	92	2007-	2010, 2012	834, 997
Stengrund	0.2	ARC	80	2010-2011, 2013-2015	2010-2011, 2013, 2015	10, 150, 120, 151
Stenskär	1.23	EGF	32	2006-2013	2013	150
Svartbådan	0.23	ARC	67	2008-2015	2011, 2013, 2015	29, 350, 173
Tärnesörarna	0.43	EGF	32	2008-	2013-2014	498, 487
Urpoinen	4.18	ARC	116	2010-	2012, 2015	686, 2670
Västra Hästhällen	0.42	EGF	31	2012-2013	2013	116

Table S2. All species used in the community analysis. Species grouped together in the table were grouped together in the analysis due to visual or taxonomic similarity. Species indicated by × were analysed in univariate analyses, either individually in either hard or soft substrate and/or included in one of the functional groups. “Hard” and “Soft” refer to habitat type and “SAV” to submerged aquatic vegetation.

	Species	Univariate analysis		Functional group in univariate analysis	
		Hard	Soft	Fil. Algae	SAV
Chlorophyta	<i>Acrosiphonia arcta</i>			×	
	<i>Chaetomorpha linum</i>			×	
	<i>Cladophora aegraophila</i> , <i>C. fracta</i> , <i>C. glomerata</i> , <i>C. rupestris</i>	×		×	
	<i>Monostroma balticum</i> , <i>M. grevillei</i>			×	
	<i>Mougeotia</i> sp.			×	
	<i>Rhizoclonium</i> sp.			×	
	<i>Spirogyra</i> spp.			×	
	<i>Ulva clathrata</i> , <i>U. compressa</i> , <i>U. intestinalis</i> , <i>U. flexuosa</i> , <i>U. prolifera</i>	×		×	
<i>Ulothrix flacca</i> , <i>U. zonata</i>			×		
Phaeophyceae	<i>Chorda filum</i> , <i>Halosiphon tomentosus</i>	×			
	<i>Dictyosiphon foeniculaceus</i> , <i>Stictyosiphon tortilis</i>	×			
	<i>Ectocarpus siliculosus</i> , <i>Pilayella littoralis</i>	×		×	
	<i>Elachista fucicola</i>				
	<i>Eudesme virescens</i>				
	<i>Fucus vesiculosus</i> , <i>F. radicans</i>	×			
	<i>Pseudolithoderma</i> spp.				
	<i>Leathesia difformis</i>				
	<i>Scytosiphon lomentaria</i>				
<i>Sphacelaria arctica</i> , <i>S. radicans</i>					
Rhodophyta	<i>Aglaothamnion roseum</i>			×	
	<i>Audouinella</i> spp.			×	
	<i>Batrachospermum</i> spp.			×	
	<i>Ceramium tenuicorne</i> , <i>C. rubrum</i> , <i>C. virgatum</i>	×		×	
	<i>Coccotylus truncatus</i> , <i>Phyllophora pseudoceranooides</i>				
	<i>Furcellaria lumbricalis</i>	×			
	<i>Hildenbrandia rubra</i>				
	<i>Polysiphonia fibrillosus</i> , <i>P. fucoides</i>	×		×	
	<i>Rhodochorton purpureum</i>				
<i>Rhodomela confervoides</i>					
Xanthophyceae	<i>Vaucheria</i> spp.	×		×	
Charophyta	<i>Chara aspera</i> , <i>C. baltica</i> , <i>C. globularis</i> , <i>C. tomentosa</i> , <i>C. virgata</i> , <i>Nitella flexilis</i> , <i>N. opaca</i> , <i>N. wahlbergia</i> , <i>Nitellopsis</i> sp.		×		
	<i>Tolypella nidifica</i>				

	<i>Callitriche hermaphroditica</i> , <i>C. palustris</i>		x
	<i>Ceratophyllum demersum</i> , <i>Myriophyllum alterniflorum</i> , <i>M. sibiricum</i> , <i>M. spicatum</i> , <i>M. verticillatum</i>	x	x
	<i>Elatine hydropiper</i>		
	<i>Elodea canadensis</i>		x
	<i>Hippuris vulgaris</i> , <i>H. lanceolata</i>		
	<i>Isoëtes</i> spp.		
	<i>Lemna trisulca</i>		
	<i>Limosella aquatica</i>		
	<i>Lysimachia thyrsiflora</i>		
	<i>Najas marina</i>		x
	<i>Nuphar lutea</i>		
Angiospermae	<i>Nymphaea alba</i>		
	<i>Phragmites australis</i>		
	<i>Potamogeton filiformis</i> , <i>P. friesii</i> , <i>P. gramineus</i> , <i>P. perfoliatus</i> , <i>P. praelongus</i> , <i>P. pusillus</i> , <i>Ruppia cirrhosa</i> , <i>R. maritima</i> , <i>Stuckenia pectinata</i> , <i>Zannichellia palustris</i>	x	x
	<i>Ranunculus baudotii</i> , <i>R. circinatus</i> , <i>R. confervoides</i> , <i>R. peltatus</i> , <i>R. reptans</i>		x
	<i>Schoenoplectus lacustris</i> , <i>S. tabernaemontani</i>		
	<i>Sparganium gramineum</i>		
	<i>Subularia aquatica</i>		
	<i>Triglochin maritima</i>		
	<i>Typha angustifolia</i> , <i>T. latifolia</i>		
	<i>Zostera marina</i>	x	x

Table S3. Number of near-colony and control data points in each geographic area, substrate type, and depth zone. ARC=Archipelago Sea, BOTB=Bothnian Bay, BOTS=Bothnian Sea, EGF=Eastern Gulf of Finland, KVA=Kvarken, WGF=Western Gulf of Finland). See Figure 1 for geographic distribution.

Near-colony data points								
	Hard substrate				Soft substrate			
	0-2.5 m	2.5-5 m	5-10 m	10-15 m	0-2.5 m	2.5-5 m	5-10 m	10-15 m
ARC	117	90	60	12	154	166	138	33
BOTB	131	126	82	3	375	113	167	91
BOTS	318	462	475	60	197	260	673	181
EGF	147	132	206	124	147	106	236	324
KVA	30	30	7	1	62	76	69	56
WGF	111	192	504	536	69	107	300	242
Total	854	1032	1334	736	1004	828	1583	927

Control data points								
	Hard substrate				Soft substrate			
	0-2.5 m	2.5-5 m	5-10 m	10-15 m	0-2.5 m	2.5-5 m	5-10 m	10-15 m
ARC	294	315	280	116	96	208	436	402
BOTB	11	9	1	0	154	33	18	4
BOTS	31	30	11	1	93	67	30	12
EGF	263	201	369	256	372	370	661	1291
KVA	16	61	49	13	36	77	267	117
WGF	224	278	506	287	333	215	229	339
Total	839	894	1216	673	1084	970	1641	2165

Table S4. Results of permutational manova (PERMANOVA) for producer communities in (a) all habitats, (b) hard substrate and (c) soft substrate habitats at different depths. SiteID was also included in all analyses as a random factor. “Treatment” refers to near-colony vs control data points.

a. All habitats			b. Hard substrate		0-2.5 m		2.5-5 m		5-10 m		10-15 m	
	Pseudo-F _{df}	p	Pseudo-F _{df}	p	Pseudo-F _{df}	p	Pseudo-F _{df}	p	Pseudo-F _{df}	p	Pseudo-F _{df}	p
Area	273.00 _{5, 17684}	<0.001	3.54 _{5, 1692}	<0.001	3.99 _{5, 1925}	<0.001	1.55 _{5, 2549}	0.11	2.02 _{5, 1408}	0.07		
Year	48.15 _{10, 17684}	<0.001	3.86 _{10, 1692}	<0.001	34.63 _{10, 1925}	<0.001	3.49 _{10, 2549}	<0.001	3.35 _{10, 1408}	<0.001		
Month	125.68 _{3, 17684}	<0.001	2.20 _{3, 1692}	<0.001	5.72 _{3, 1925}	<0.001	4.14 _{3, 2549}	<0.001	2.61 _{3, 1408}	0.008		
Depth	2661.54 _{1, 17684}	<0.001	12.55 _{1, 1692}	<0.001	18.32 _{1, 1925}	<0.001	46.13 _{1, 2549}	<0.001	35.59 _{1, 1408}	<0.001		
Substrate	666.81 _{1, 17684}	<0.001	21.32 _{1, 1692}	<0.001	2.72 _{1, 1925}	0.007	0.92 _{1, 2549}	0.54	1.33 _{1, 1408}	0.18		
Exposure	148.42 _{1, 17684}	<0.001	0.86 _{1, 1692}	0.79	2.82 _{1, 1925}	<0.001	9.06 _{1, 2549}	<0.001	5.31 _{1, 1408}	<0.001		
Temperature	37.27 _{1, 17684}	<0.001	1.60 _{1, 1692}	0.02	1.32 _{1, 1925}	0.041	0.86 _{1, 2549}	0.85	0.54 _{1, 1408}	0.99		
Salinity	66.08 _{1, 17684}	<0.001	8.06 _{1, 1692}	<0.001	11.78 _{1, 1925}	<0.001	10.62 _{1, 2549}	0.001	2.75 _{1, 1408}	<0.001		
Secchi depth	11.61 _{1, 17684}	<0.001	0.69 _{1, 1692}	0.99	1.29 _{1, 1925}	0.027	1.75 _{1, 2549}	0.002	0.59 _{1, 1408}	0.99		
Nitrogen	29.33 _{1, 17684}	<0.001	1.94 _{1, 1692}	<0.001	1.61 _{1, 1925}	<0.001	1.74 _{1, 2549}	0.003	4.95 _{1, 1408}	<0.001		
Treatment	6.20 _{1, 17684}	<0.001	1.01 _{1, 1692}	0.40	3.19 _{1, 1925}	0.002	1.69 _{1, 2549}	0.001	0.76 _{1, 1408}	0.75		

c. Soft substrate		0-2.5 m		2.5-5 m		5-10 m		10-15 m	
	Pseudo-F _{df}	p	Pseudo-F _{df}	p	Pseudo-F _{df}	p	Pseudo-F _{df}	p	
Area	1.88 _{5, 2087}	0.007	2.41 _{5, 1797}	0.008	1.33 _{5, 3223}	0.17	0.61 _{5, 3091}	0.55	
Year	2.34 _{10, 2087}	<0.001	2.38 _{10, 1797}	<0.001	2.91 _{10, 3223}	<0.001	2.62 _{9, 3091}	<0.001	
Month	3.32 _{3, 2087}	<0.001	2.62 _{3, 1797}	<0.001	6.41 _{3, 3223}	<0.001	1.03 _{3, 3091}	0.40	
Depth	5.80 _{1, 2087}	<0.001	53.91 _{1, 1797}	<0.001	66.99 _{1, 3223}	<0.001	7.35 _{1, 3091}	<0.001	
Substrate	10.07 _{1, 2087}	<0.001	26.42 _{1, 1797}	<0.001	85.15 _{1, 3223}	<0.001	13.17 _{1, 3091}	<0.001	
Exposure	2.07 _{1, 2087}	0.003	2.22 _{1, 1797}	0.003	5.10 _{1, 3223}	<0.001	1.48 _{1, 3091}	0.09	
Temperature	1.02 _{1, 2087}	0.43	2.86 _{1, 1797}	<0.001	1.38 _{1, 3223}	0.08	1.14 _{1, 3091}	0.32	
Salinity	5.00 _{1, 2087}	<0.001	8.75 _{1, 1797}	<0.001	9.24 _{1, 3223}	<0.001	1.58 _{1, 3091}	0.05	
Secchi depth	1.12 _{1, 2087}	0.19	2.31 _{1, 1797}	<0.001	1.39 _{1, 3223}	0.01	1.24 _{1, 3091}	0.23	
Nitrogen	1.01 _{1, 2087}	0.43	0.93 _{1, 1797}	0.56	1.34 _{1, 3223}	0.04	1.01 _{1, 3091}	0.50	
Treatment	0.91 _{1, 1692}	0.60	0.47 _{1, 1797}	0.99	0.25 _{1, 3223}	0.99	0.18 _{1, 3091}	0.99	

Table S5. Percentage cumulative explained variation of environmental factors for vegetation communities in near-colony data points in all habitats and at four depths in hard and soft substrate habitats, from sequential tests of DistLM analysis. Factors in each model were chosen based on prior analysis of the best model including cormorant index (n/i indicates a factor not included), and were added to the model in the order listed. Also shown is the contribution of the cormorant index to the cumulative explained variation of each model, as well as whether the addition of cormorant index to the model significantly improved AICc values (values in bold are significant at $p < 0.05$).

Environmental variables	All habitats	Hard substrate				Soft substrate			
		0-2.5 m	2.5-5 m	5-10 m	10-15 m	0-2.5 m	2.5-5 m	5-10 m	10-15 m
SiteID	13.51	29.65	39.31	32.10	17.34	17.40	31.56	21.24	15.72
Year	15.14	33.36	42.74	35.19	22.06	22.12	33.73	22.89	18.81
Month	16.49	33.99	44.43	36.53	23.27	23.32	34.45	24.19	19.47
Depth	24.75	34.93	45.40	38.75	<i>n/i</i>	24.34	36.84	25.99	20.70
Substrate	26.65	36.72	45.82	38.92	<i>n/i</i>	25.35	39.13	<i>n/i</i>	24.51
Exposure	26.86	37.40	46.24	39.03	23.60	25.74	<i>n/i</i>	<i>n/i</i>	24.54
Temperature	26.93	37.58	46.51	39.19	<i>n/i</i>	25.95	<i>n/i</i>	26.17	<i>n/i</i>
Salinity	27.05	37.89	46.74	39.29	23.82	26.67	39.21	26.25	<i>n/i</i>
Secchi depth	27.07	38.56	46.85	<i>n/i</i>	<i>n/i</i>	26.88	39.30	26.37	<i>n/i</i>
Nitrogen	27.18	38.82	47.20	39.62	<i>n/i</i>	27.49	40.20	<i>n/i</i>	24.56
Cormorant index	27.26	39.13	47.47	40.28	23.95	27.72	40.63	26.50	24.86
Contribution of cormorant index (%)	0.08	0.32	0.27	0.66	0.13	0.23	0.42	0.12	0.30
p-value of adding cormorant index	0.005	0.002	0.001	0.001	0.25	0.006	0.001	0.048	0.013

Table S6. Full list of best models selected during the first step of the DistLM analysis of vegetation communities in near-colony data points in (a) hard and (b) soft substrate habitats. When two models had similar AICc and R² values, the simpler model was chosen. The chosen models are highlighted in bold, and presented in Table S6. For the full dataset, the best model included all variables except Area.

a. Hard substrate														
Depth	AICc	R ²	Area	SiteID	Year	Month	Depth	Substr	Exp	Temp	Sal	Secchi	N	Cl
0-2.5 m	6560	0.391		+	+	+	+	+	+	+	+	+	+	+
	6560	0.391	+	+	+	+	+	+	+	+	+	+	+	+
	6561	0.389		+	+	+	+	+	+	+		+	+	+
	6561	0.389	+	+	+	+	+	+	+	+		+	+	+
	6561	0.389	+	+	+	+	+		+	+	+	+	+	+
	6561	0.389		+	+	+	+		+	+	+	+	+	+
	6562	0.389		+	+	+	+	+	+		+	+	+	+
	6562	0.389	+	+	+	+	+	+	+		+	+	+	+
	6562	0.388	+	+	+	+	+	+	+	+	+		+	+
	6562	0.388		+	+	+	+	+	+	+	+		+	+
2.5-5 m	7771	0.475		+	+	+	+	+	+	+	+	+	+	+
	7771	0.475	+	+	+	+	+	+	+	+	+	+	+	+
	7771	0.474	+	+	+	+	+	+		+	+	+	+	+
	7771	0.474		+	+	+	+	+		+	+	+	+	+
	7773	0.473	+	+	+	+	+		+	+	+	+	+	+
	7773	0.473		+	+	+	+		+	+	+	+	+	+
	7773	0.472	+	+	+	+	+			+	+	+	+	+
	7773	0.472		+	+	+	+			+	+	+	+	+
	7774	0.472		+	+	+	+	+	+	+	+			+
	7774	0.472	+	+	+	+	+	+	+	+	+		+	+
5-10 m	10229	0.404		+	+	+	+	+	+	+	+		+	+
	10229	0.404	+	+	+	+	+	+	+	+	+		+	+
	10230	0.405		+	+	+	+	+	+	+	+	+	+	+
	10230	0.405	+	+	+	+	+	+	+	+	+	+	+	+
	10230	0.402	+	+	+	+		+	+	+	+		+	+
	10230	0.402		+	+	+		+	+	+	+		+	+
	10230	0.402	+	+	+	+	+	+	+	+	+		+	+
	10231	0.401	+	+	+	+	+		+	+	+		+	+
	10231	0.401		+	+	+	+		+	+	+		+	+
10-15 m	5664	0.257		+	+	+			+	+	+			+
	5664	0.257	+	+	+	+			+	+	+			+
	5664	0.259	+	+	+	+		+	+	+	+			+
	5664	0.259		+	+	+		+	+	+	+			+
	5665	0.257		+	+	+		+	+	+	+			+
	5665	0.257	+	+	+	+		+	+	+	+			+
	5665	0.259		+	+	+			+	+	+	+		+
	5665	0.259	+	+	+	+				+	+	+		+
	5665	0.259		+	+	+		+	+	+	+		+	+
	5665	0.259	+	+	+	+		+	+	+	+		+	+

b. Soft substrate														
Depth	AICc	R2	Area	SiteID	Year	Month	Depth	Substr	Exp	Temp	Sal	Secchi	N	CI
0-2.5 m	8065	0.277		+	+	+	+	+	+	+	+	+	+	+
	8065	0.277	+	+	+	+	+	+	+	+	+	+	+	+
	8066	0.275		+	+	+	+	+	+	+	+	+		+
	8066	0.275	+	+	+	+	+	+	+	+	+	+		+
	8066	0.275	+	+	+	+	+		+	+	+	+	+	+
	8066	0.275		+	+	+	+		+	+	+	+	+	+
	8066	0.275		+	+	+	+	+	+	+	+		+	+
	8066	0.275	+	+	+	+	+	+	+	+	+		+	+
	8066	0.274		+	+	+	+	+		+	+	+	+	+
	8066	0.274	+	+	+	+	+	+		+	+	+	+	+
2.5-5 m	6444	0.421		+	+	+	+	+			+	+	+	+
	6444	0.421	+	+	+	+	+	+			+	+	+	+
	6445	0.422		+	+	+	+	+		+	+	+	+	+
	6445	0.422	+	+	+	+	+	+		+	+	+	+	+
	6445	0.422	+	+	+	+	+	+	+		+	+	+	+
	6445	0.422		+	+	+	+	+	+		+	+	+	+
	6446	0.423	+	+	+	+	+	+	+	+	+	+	+	+
	6446	0.423		+	+	+	+	+	+	+	+	+	+	+
	6446	0.418	+	+	+	+	+	+			+	+	+	+
	6446	0.418		+	+	+	+	+			+	+	+	+
5-10 m	12053	0.309		+	+	+	+	+		+	+	+		+
	12053	0.309	+	+	+	+	+	+		+	+	+		+
	12054	0.309	+	+	+	+	+	+	+	+	+	+		+
	12054	0.309		+	+	+	+	+	+	+	+	+		+
	12054	0.309		+	+	+	+	+		+	+	+	+	+
	12054	0.309	+	+	+	+	+	+		+	+	+	+	+
	12054	0.307		+	+	+	+	+			+	+		+
	12054	0.307	+	+	+	+	+	+			+	+		+
	12054	0.308		+	+	+	+	+	+	+		+		+
	12054	0.308	+	+	+	+	+	+	+	+		+		+
10-15 m	6311	0.253		+	+	+	+	+	+				+	+
	6311	0.253	+	+	+	+	+	+	+				+	+
	6311	0.254	+	+	+	+	+	+	+	+			+	+
	6311	0.254		+	+	+	+	+	+	+			+	+
	6311	0.250		+	+	+	+	+					+	+
	6311	0.250	+	+	+	+	+	+					+	+
	6312	0.248		+	+	+	+	+					+	+
	6312	0.248	+	+	+	+	+	+					+	+
	6312	0.250	+	+	+	+	+	+	+				+	+
	6312	0.250		+	+	+	+	+	+				+	+

Table S7. Results of general linear mixed model (GLMM) with quasibinomial distribution for the abundance of common species and functional groups. SiteID was included as a random factor. “Treatment” refers to near-colony vs control. Degrees of freedom are given as numerator df, denominator df. Values in bold indicate statistically significant ($p < 0.05$) values. *Fucus* spp. included points from BOTS, ARC, WGF, EGF, while *Z. marina* included ARC, WGF.

Hard substrate	<i>Cladophora</i> spp. 0-5 m		<i>Ulva</i> spp. 0-2.5 m		<i>Chorda filum</i> 0-5 m		<i>Dictyosiphon/ Stictyosiphon</i> 0-5 m		<i>Ectocarpus/ Pilayella</i> 0-10 m	
	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p
Area	5.88 _{5, 3527}	<0.0001	0.88 _{5, 57}	0.5	1.64 _{5, 3527}	0.15	4.61 _{5, 3527}	0.0003	4.34 _{5, 6076}	0.0006
Year	10.00 _{10, 3527}	<0.0001	6.96 _{10, 1609}	<0.0001	2.87 _{10, 3527}	<0.0001	2.94 _{10, 3527}	0.12	16.94 _{10, 6076}	<0.0001
Month	5.59 _{3, 3527}	0.0008	2.37 _{3, 1609}	0.06	10.39 _{3, 3527}	<0.0001	1.93 _{3, 3527}	0.12	31.77 _{3, 6076}	<0.0001
Depth	232.29 _{1, 3527}	<0.0001	58.78 _{1, 1609}	<0.0001	12.47 _{1, 3527}	0.0004	5.69 _{1, 3527}	0.0171	225.91 _{1, 6076}	<0.0001
Substrate	31.42 _{1, 3527}	<0.0001	0.38 _{1, 1609}	0.54	37.67 _{1, 3527}	<0.0001	0.47 _{1, 3527}	0.49	89.05 _{1, 6076}	<0.0001
Exposure	27.82 _{1, 3527}	<0.0001	0.03 _{1, 1609}	0.86	16.78 _{1, 3527}	<0.0001	1.68 _{1, 3527}	0.19	3.67 _{1, 6076}	0.05
Temperature	4.74 _{1, 3527}	0.0295	0.64 _{1, 1669}	0.42	4.09 _{1, 3527}	0.0431	1.16 _{1, 3527}	0.28	0.52 _{1, 6076}	0.47
Salinity	0.01 _{1, 3527}	0.99	0.05 _{1, 1669}	0.83	0.11 _{1, 3527}	0.74	4.74 _{1, 3527}	0.0296	0.65 _{1, 6076}	0.42
Secchi depth	0.99 _{1, 3527}	0.32	0.40 _{1, 1669}	0.53	0.45 _{1, 3527}	0.50	4.89 _{1, 3527}	0.0271	4.54 _{1, 6076}	0.0331
Nitrogen	0.95 _{1, 3527}	0.33	3.26 _{1, 1669}	0.07	22.21 _{1, 3527}	<0.001	2.87 _{1, 3527}	0.09	1.16 _{1, 6076}	0.28
Treatment	0.18 _{1, 65}	0.67	0.81 _{1, 57}	0.37	2.12 _{1, 65}	0.15	0.56 _{1, 65}	0.46	1.68 _{1, 66}	0.20

Hard substrate cont'd	<i>Fucus</i> spp. 0-5 m		<i>Ceramium</i> spp. 0-10 m		<i>Furcellaria lumbricalis</i> 5-10 m		<i>Polysiphonia</i> spp. 0-10 m		Filamentous algae 0-10 m	
	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p
Area	1.54 _{3, 3124}	0.2	5.54 _{5, 6076}	<0.0001	1.43 _{5, 6076}	0.21	0.50 _{5, 6076}	0.78	3.64 _{5, 6076}	0.0027
Year	8.98 _{10, 3124}	<0.0001	8.21 _{10, 6076}	<0.0001	20.91 _{10, 6076}	<0.0001	43.14 _{10, 6076}	<0.0001	32.67 _{10, 6076}	<0.0001
Month	2.05 _{3, 3124}	0.10	11.83 _{3, 6076}	<0.0001	23.42 _{3, 6076}	<0.0001	27.36 _{3, 6076}	<0.0001	40.61 _{3, 6076}	<0.0001
Depth	129.80 _{1, 3124}	<0.0001	6.31 _{1, 6076}	0.0120	42.04 _{1, 6076}	<0.0001	4.74 _{1, 6076}	0.0295	293.26 _{1, 6076}	<0.0001
Substrate	41.91 _{1, 3124}	<0.0001	29.02 _{1, 6076}	<0.0001	0.56 _{1, 6076}	0.46	0.93 _{1, 6076}	0.33	164.78 _{1, 6076}	<0.0001
Exposure	0.03 _{1, 3124}	0.86	90.43 _{1, 6076}	<0.0001	27.77 _{1, 6076}	<0.0001	0.14 _{1, 6076}	0.91	101.71 _{1, 6076}	<0.0001
Temperature	0.38 _{1, 3124}	0.54	0.01 _{1, 6076}	0.99	3.00 _{1, 6076}	0.08	16.60 _{1, 6076}	<0.0001	7.60 _{1, 6076}	0.0058
Salinity	1.70 _{1, 3124}	0.19	61.83 _{1, 6076}	<0.0001	3.55 _{1, 6076}	0.06	8.93 _{1, 6076}	0.0028	47.46 _{1, 6076}	<0.0001
Secchi depth	4.00 _{1, 3124}	0.046	2.20 _{1, 6076}	0.14	35.44 _{1, 6076}	<0.0001	5.37 _{1, 6076}	0.021	0.01 _{1, 6076}	0.97
Nitrogen	0.65 _{1, 3124}	0.42	0.08 _{1, 6076}	0.78	2.20 _{1, 6076}	0.15	1.95 _{1, 6076}	0.16	0.23 _{1, 6076}	0.63
Treatment	0.02 _{1, 56}	0.88	4.78 _{1, 66}	0.0323	0.97 _{1, 66}	0.33	0.03 _{1, 66}	0.85	1.09 _{1, 66}	0.30

Soft substrate	Charophytes 0-5 m		<i>Ceratophyllum/Myriophyllum</i> 0-5 m		<i>Potamogeton/Ruppia/Stuckenia/Zannichellia</i> 0-5 m		<i>Zostera marina</i> 0-5 m		SAV 0-5 m		Filamentous algae 0-10 m	
	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p
Area	8.80 _{5, 3797}	<0.0001	1.06 _{5, 3797}	0.38	4.07 _{5, 3797}	0.0011	163.01 _{1, 1306}	<0.0001	4.66 _{5, 3797}	0.0003	1.62 _{5, 7018}	0.15
Year	8.23 _{10, 3797}	<0.0001	0.35 _{10, 3797}	0.97	13.51 _{10, 3797}	<0.0001	0.01 _{9, 1306}	0.99	13.77 _{10, 3797}	<0.0001	1.44 _{10, 7018}	0.16
Month	9.07 _{3, 3797}	<0.0001	0.54 _{3, 3797}	0.65	19.01 _{3, 3797}	<0.0001	83.10 _{3, 1306}	<0.0001	9.84 _{3, 3797}	<0.0001	6.35 _{3, 7018}	0.0003
Depth	125.92 _{1, 3797}	<0.0001	3.08 _{1, 3797}	0.08	161.50 _{1, 3797}	<0.0001	2.28 _{1, 1306}	0.13	157.19 _{1, 3797}	<0.0001	165.49 _{1, 7018}	<0.0001
Substrate	4.74 _{1, 3797}	0.030	0.12 _{1, 3797}	0.73	11.42 _{1, 3797}	0.0007	139.98 _{1, 1306}	<0.0001	22.61 _{1, 3797}	<0.0001	904.22 _{1, 7018}	<0.0001
Exposure	1.86 _{1, 3797}	0.17	1.34 _{1, 3797}	0.25	31.94 _{1, 3797}	<0.0001	914.37 _{1, 1306}	<0.0001	6.88 _{1, 3797}	0.0088	79.19 _{1, 7018}	<0.0001
Temperature	1.23 _{1, 3797}	0.27	1.81 _{1, 3797}	0.18	3.47 _{1, 3797}	0.06	537.31 _{1, 1306}	<0.0001	10.75 _{1, 3797}	0.0011	5.01 _{1, 7018}	0.0252
Salinity	0.01 _{1, 3797}	0.98	0.01 _{1, 3797}	0.94	2.97 _{1, 3797}	0.09	4.53 _{1, 1306}	0.033	2.27 _{1, 3797}	0.13	20.29 _{1, 7018}	<0.0001
Secchi depth	1.12 _{1, 3797}	0.29	2.11 _{1, 3797}	0.15	4.28 _{1, 3797}	0.039	1.25 _{1, 1306}	0.26	1.80 _{1, 3797}	0.18	0.01 _{1, 7018}	0.97
Nitrogen	4.17 _{1, 3797}	0.041	4.73 _{1, 3797}	0.0230	0.47 _{1, 3797}	0.49	282.67 _{1, 1306}	<0.0001	7.72 _{1, 3797}	0.0055	12.84 _{1, 7018}	0.0003
Treatment	0.33 _{1, 62}	0.57	0.06 _{1, 62}	0.81	0.01 _{1, 62}	0.92	5.38 _{1, 29}	0.028	0.08 _{1, 62}	0.78	0.04 _{1, 65}	0.84

Table S8. Results of general linear mixed model (GLMM) with binomial distribution for the presence/absence of foundation species bladderwrack *Fucus* spp. (BOTS, ARC, WGF, EGF) and eelgrass *Zostera marina* (ARC, WGF). SiteID was included as a random factor. “Treatment” refers to near-colony vs control. Degrees of freedom (df) are given as numerator df, denominator df. Values in bold indicate statistically significant ($p < 0.05$) values.

	<i>Fucus</i> spp.		<i>Zostera marina</i>	
	F _{df}	p	F _{df}	p
Area	5.63 _{3, 3124}	0.0008	77.41 _{1, 1306}	<0.0001
Year	5.08 _{10, 3124}	<0.0001	17.26 _{9, 1306}	<0.0001
Month	3.42 _{3, 3124}	0.02	17.18 _{3, 1306}	<0.0001
Depth	82.29 _{1, 3124}	<0.0001	82.20 _{1, 1306}	<0.0001
Substrate	0.62 _{1, 3124}	0.43	3.23 _{1, 1306}	0.07
Exposure	0.01 _{1, 3124}	0.97	16.84 _{1, 1306}	<0.0001
Temperature	1.71 _{1, 3124}	0.19	11.30 _{1, 1306}	0.0008
Salinity	0.55 _{1, 3124}	0.46	16.87 _{1, 1306}	<0.0001
Secchi depth	0.69 _{1, 3124}	0.41	1.59 _{1, 1306}	0.21
Nitrogen	4.83 _{1, 3124}	0.0280	18.58 _{1, 1306}	<0.0001
Treatment	0.34 _{1, 56}	0.56	3.90 _{1, 29}	0.028

Table S9. Results of general linear mixed model (GLMM) regression with quasibinomial distribution for abundance of the following species near-colony points: foundation species bladderwrack *Fucus* spp. (in geographic areas BOTS, ARC, WGF, and EGF) and *Zostera marina* (in geographic areas ARC and WGF), along with filamentous algae in hard and soft substrates (in all areas). SiteID was included as a random factor. Degrees of freedom (df) are given as numerator df, denominator df. Values in bold indicate statistically significant ($p < 0.05$) values. Directions of effects are shown in Figure 4.

	<i>Fucus</i> spp. (hard substrate 0-5 m)		<i>Zostera marina</i> (soft substrate 0-5 m)		Filamentous algae (hard substrate 0-10 m)		Filamentous algae (soft substrate 0-10 m)	
	F _{df}	p	F _{df}	p	F _{df}	p	F _{df}	p
Area	1.17 _{3, 1521}	0.34	0.03 _{1, 462}	0.86	5.63 _{3, 3124}	0.0008	77.41 _{1, 1306}	<0.0001
Year	9.91 _{6, 1521}	<0.0001	0.01 _{6, 462}	0.99	5.08 _{10, 3124}	<0.0001	17.26 _{9, 1306}	<0.0001
Month	5.38 _{3, 1521}	0.011	0.01 _{3, 462}	0.99	3.42 _{3, 3124}	0.02	17.18 _{9, 1306}	<0.0001
Depth	53.84 _{1, 1521}	<0.0001	0.03 _{1, 462}	0.86	82.29 _{1, 3124}	<0.0001	82.20 _{3, 1306}	<0.0001
Substrate	41.46 _{1, 1521}	<0.0001	0.01 _{1, 462}	0.99	0.62 _{1, 3124}	0.43	3.23 _{1, 1306}	0.07
Exposure	5.82 _{1, 1521}	0.016	0.05 _{1, 462}	0.23	0.01 _{1, 3124}	0.97	16.84 _{1, 1306}	<0.0001
Temperature	0.11 _{1, 1521}	0.74	0.01 _{1, 462}	0.99	1.71 _{1, 3124}	0.19	11.30 _{1, 1306}	0.0008
Salinity	0.93 _{1, 1521}	0.34	0.01 _{1, 462}	0.98	0.55 _{1, 3124}	0.46	16.87 _{1, 1306}	<0.0001
Secchi depth	1.43 _{1, 1521}	0.23	0.01 _{1, 462}	0.93	0.69 _{1, 3124}	0.41	1.59 _{1, 1306}	0.21
Nitrogen	1.04 _{1, 1521}	0.31	0.01 _{1, 462}	0.97	4.83 _{1, 3124}	0.0280	18.58 _{1, 1306}	<0.0001
Cormorant index	8.08 _{1, 1521}	0.0045	0.01 _{1, 462}	0.93	0.34 _{1, 56}	0.56	3.90 _{1, 29}	0.028

Supplementary Figures

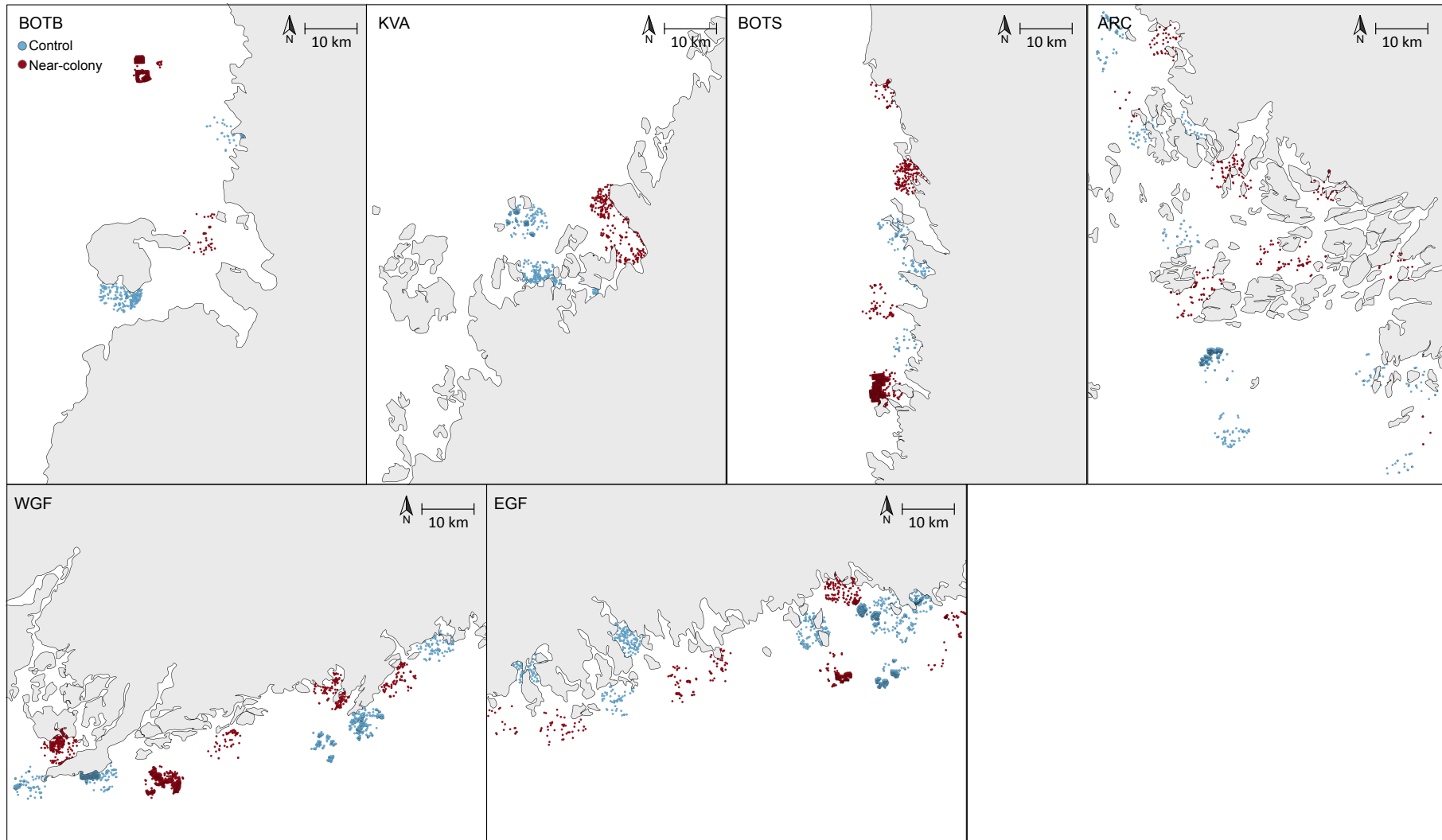


Fig. S1. Closeup of geographic areas (see Fig. 1 for overview and abbreviations of geographic areas). Dark red points=near-colony (<5 km from colony, light blue points=control (>10 km from colony)

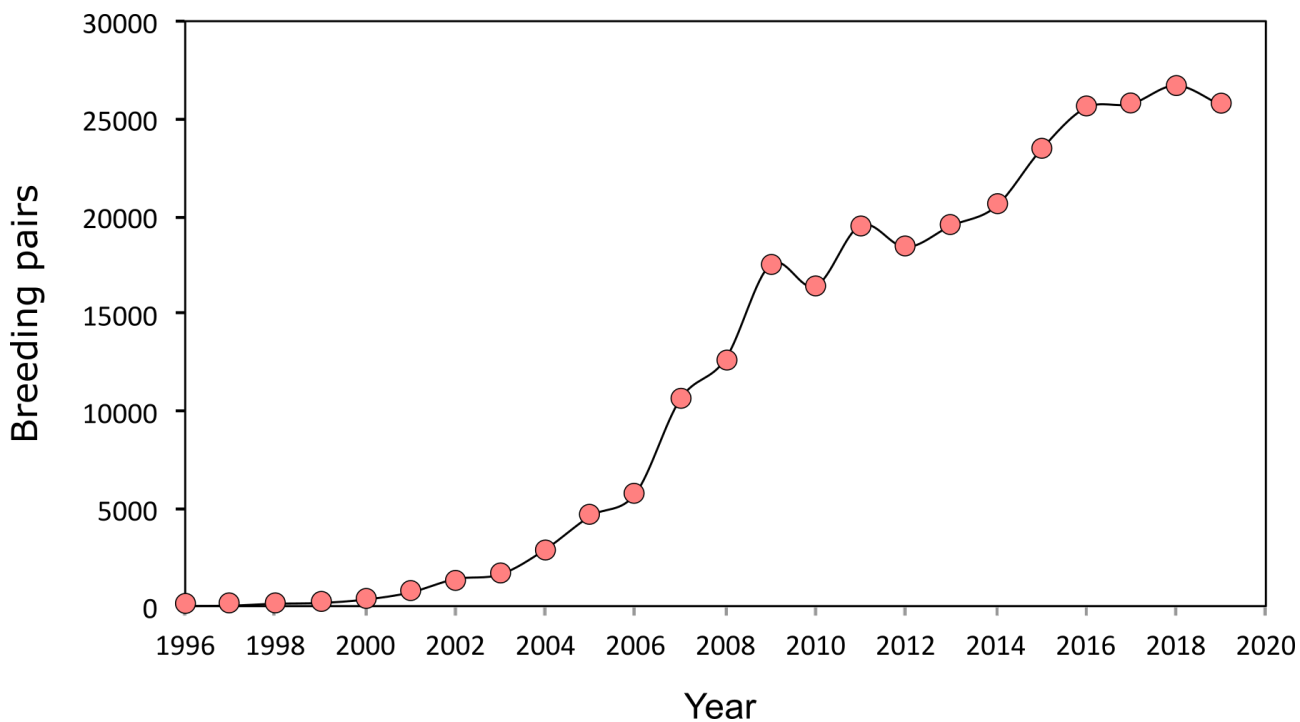


Fig. S2. Development of the Great Cormorant population in Finland 1996-2019, based on monitoring data from the Finnish Environment Institute (SYKE).

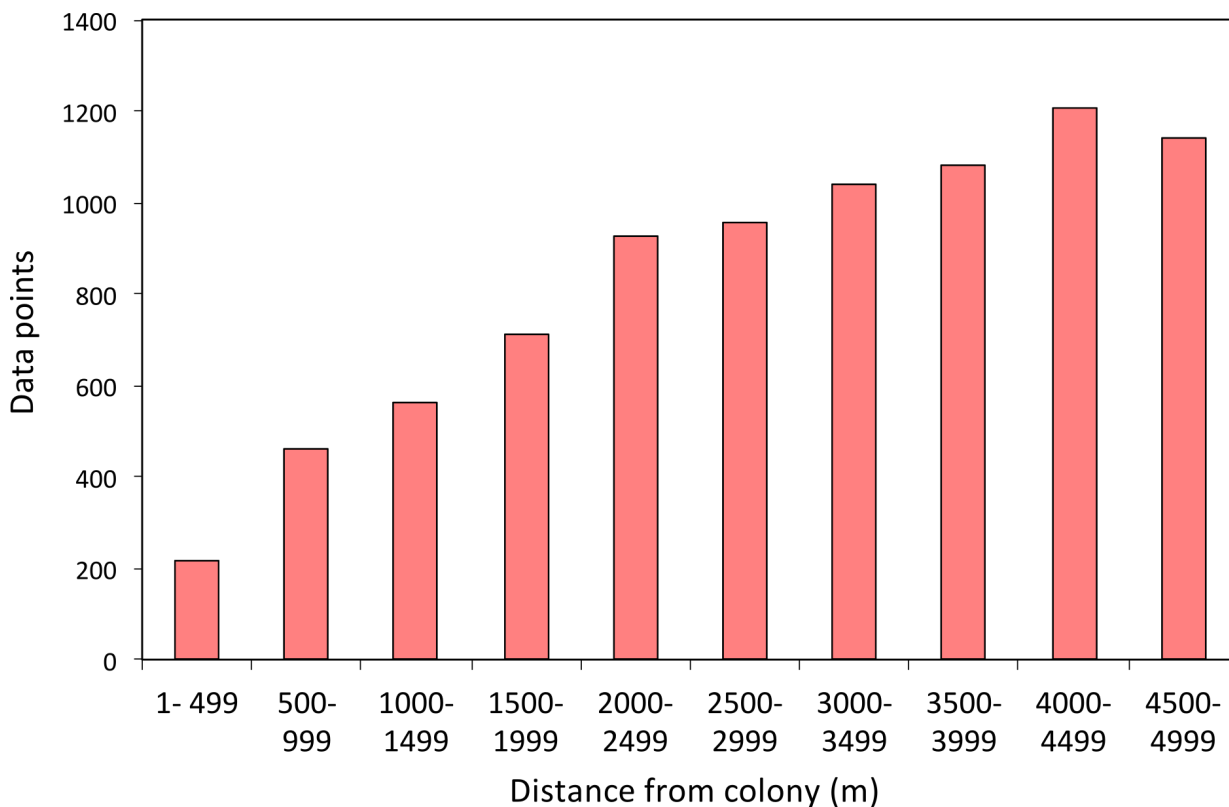


Fig. S3. Distribution of near-colony data points by distance from colonies. For points that were within 5 km of two colonies, only the distance from the nearest colony is represented.

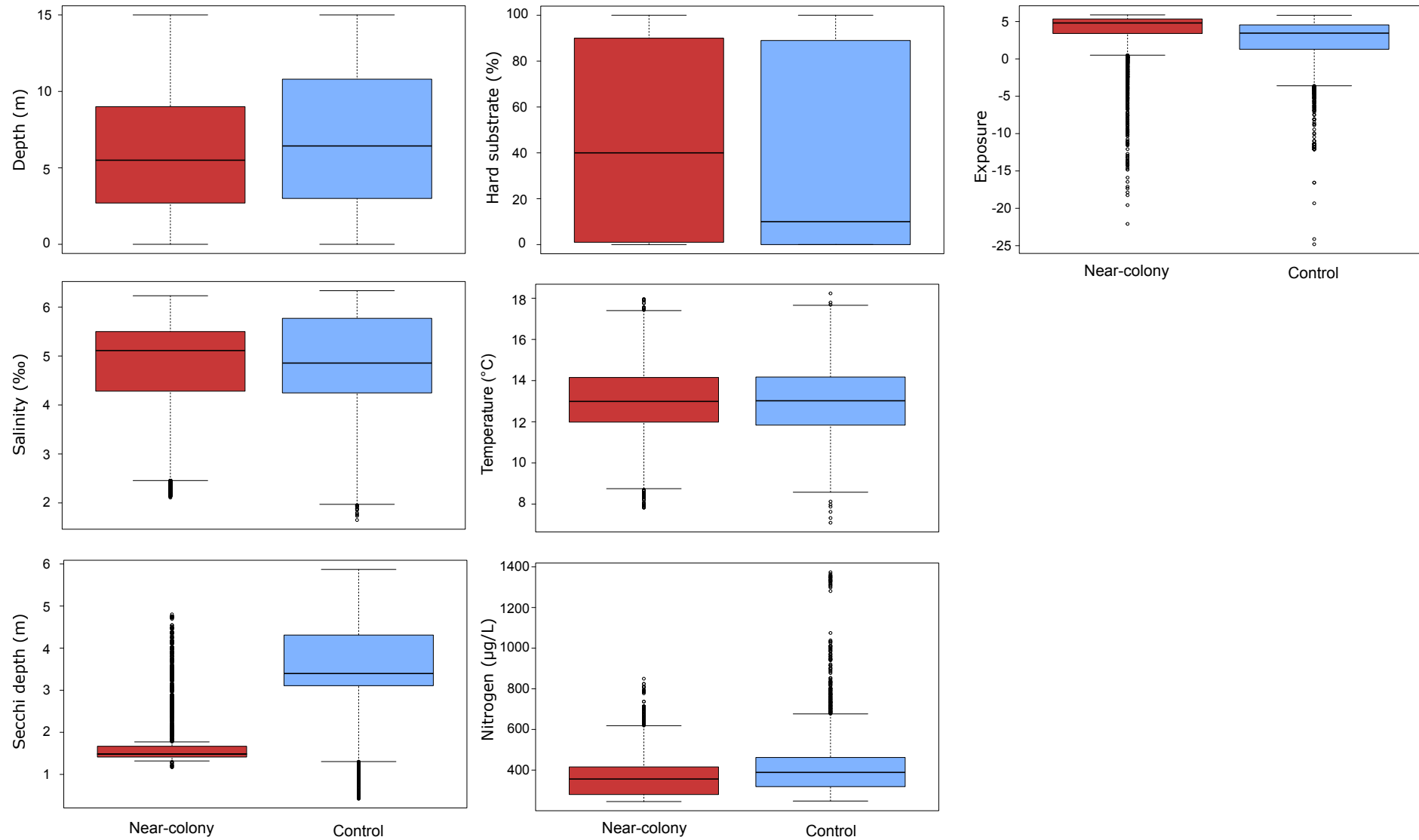
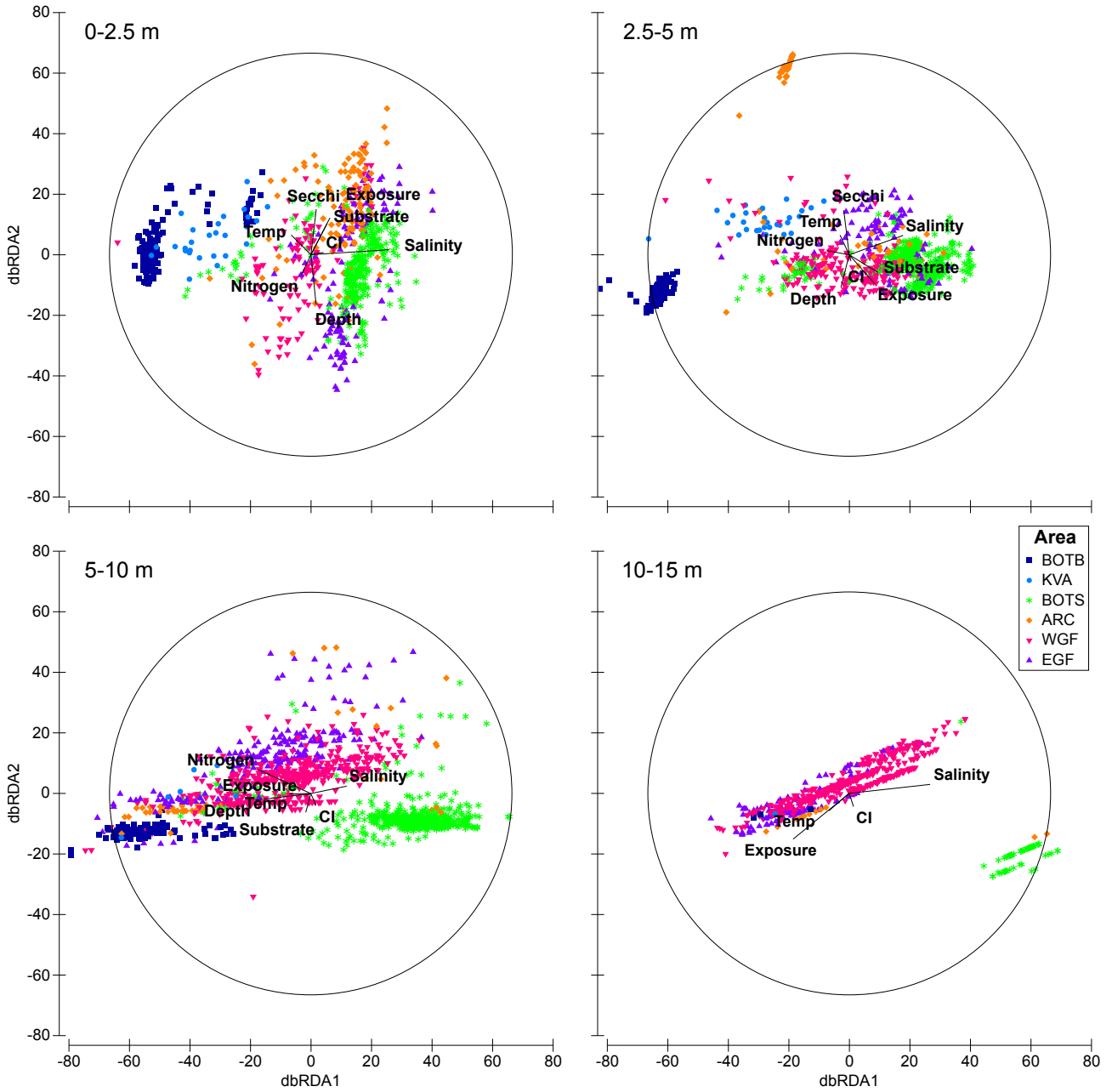


Fig. S4. Boxplots of environmental variables in near-colony and control data points (all data points from all geographic areas included).

a. Hard substrate



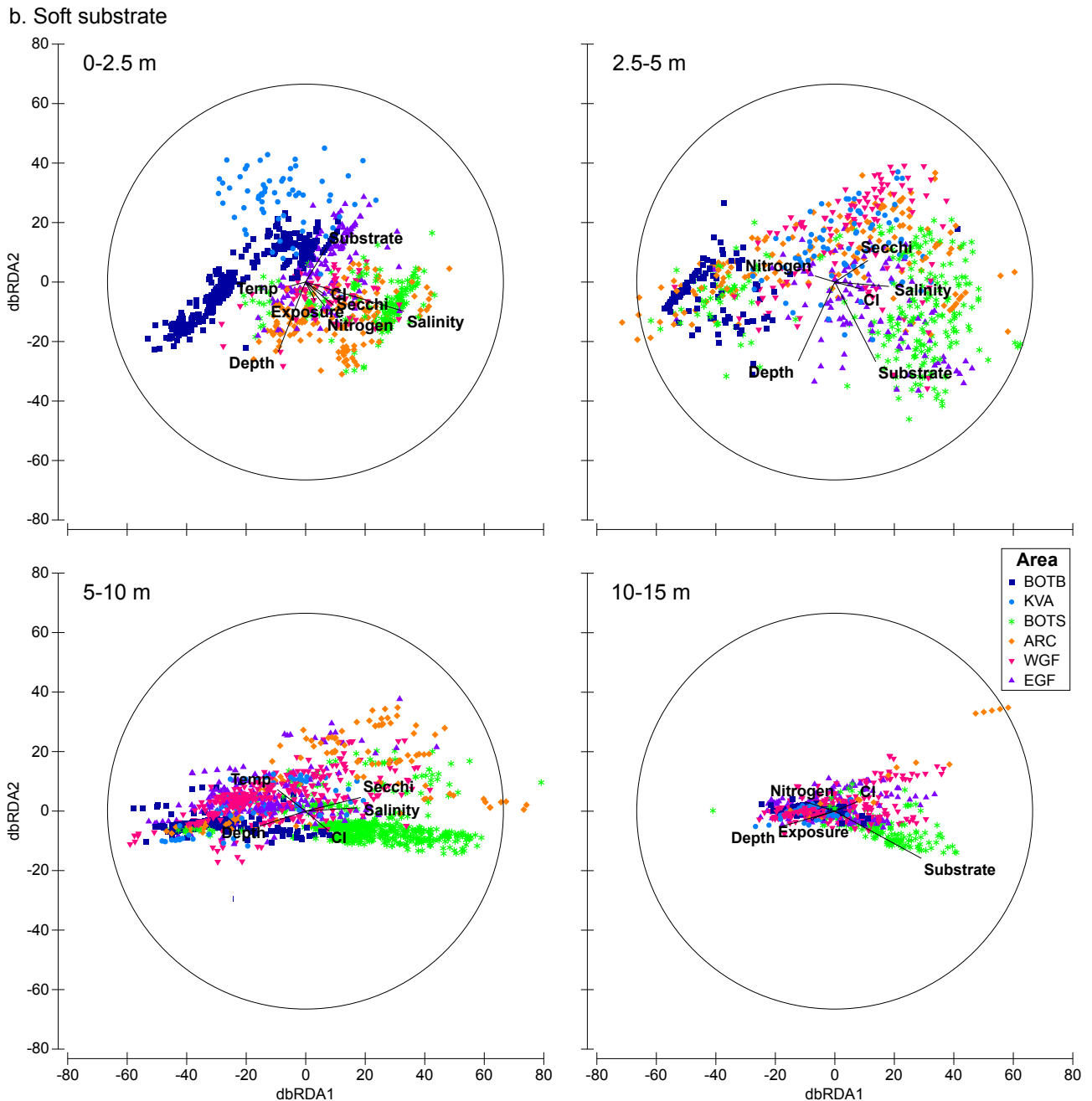


Fig. S5. DbRDA plots of vegetation communities in near-colony data points in each depth zone in (a) hard and (b) soft substrates. See Fig. 2 for relative importance of each environmental variable, and Tables S5 and S6 for full model. Temp=mean Temperature, Substrate=% hard Substrate, Salinity=bottom Salinity, CI=Cormorant Index). Year, Month, and SiteID were included in all models, but are not shown. The length of each line represents the multiple partial correlation of the factor with the RDA-axes (i.e. the relative importance of the factor). Colours/shapes indicate geographic areas (see Fig. 1 for abbreviations).

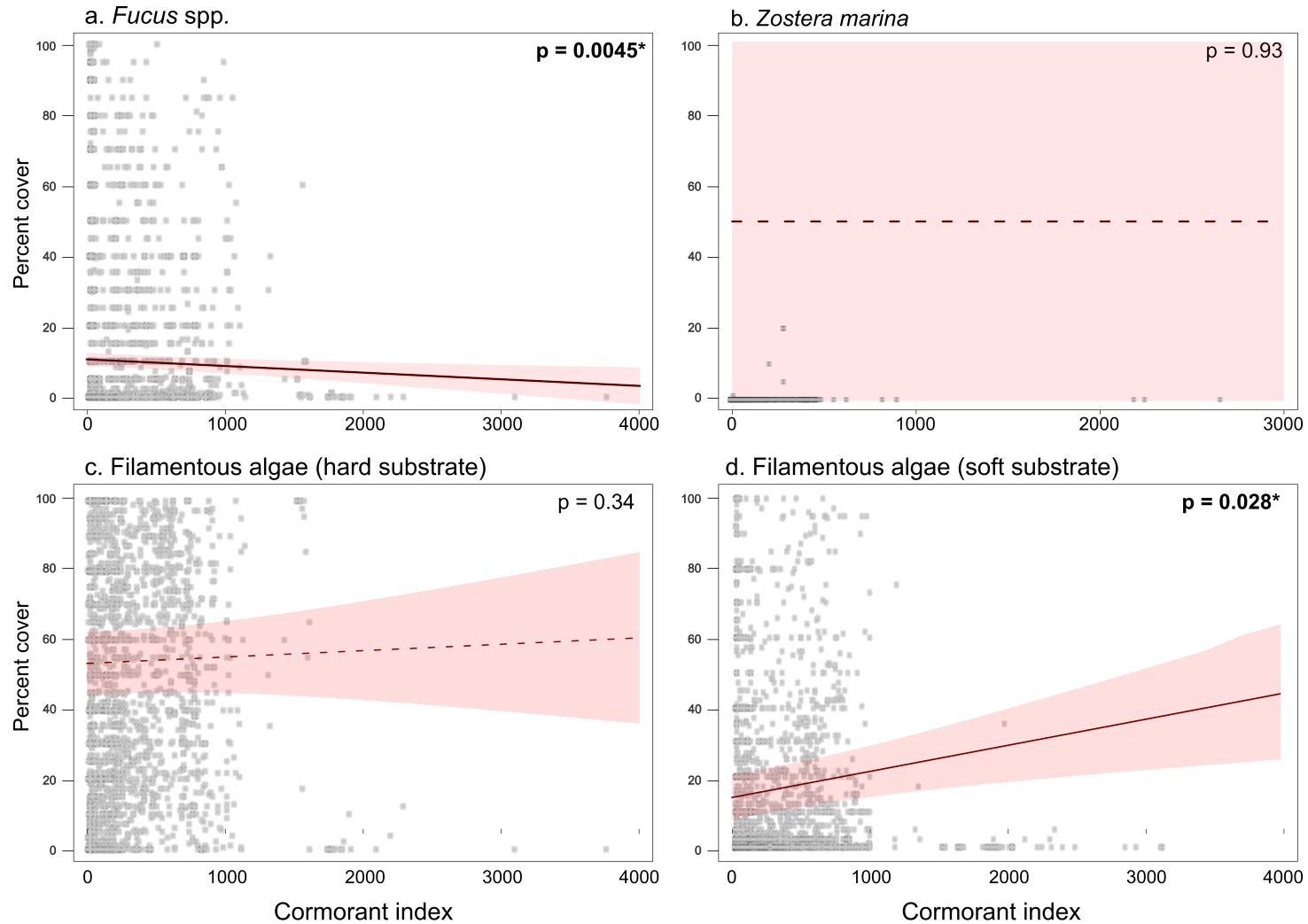


Fig. S6. Effect of cormorant index on cover of (a) *Fucus* spp. (hard substrates 0-5 m in BOTS, ARC, WGF, EGF) (b) *Zostera marina* (soft substrates 0-5 m in ARC, WGF), and filamentous algae cover in (c) hard and (d) soft substrates (0-10 m in all geographic areas) in near-colony data points. Data points are shown in grey, while the light shading around the red line indicates the 95% confidence limits. Significant regressions are indicated by unbroken lines, and non-significant relationships by dashed lines. Full results are shown in Table S9.