SUPPLEMENTARY MATERIALS FOR

OPTIMIZING LARGE-SCALE BIODIVERSITY SAMPLING EFFORTS

TOWARD AN UNBALANCED SURVEY DESIGN

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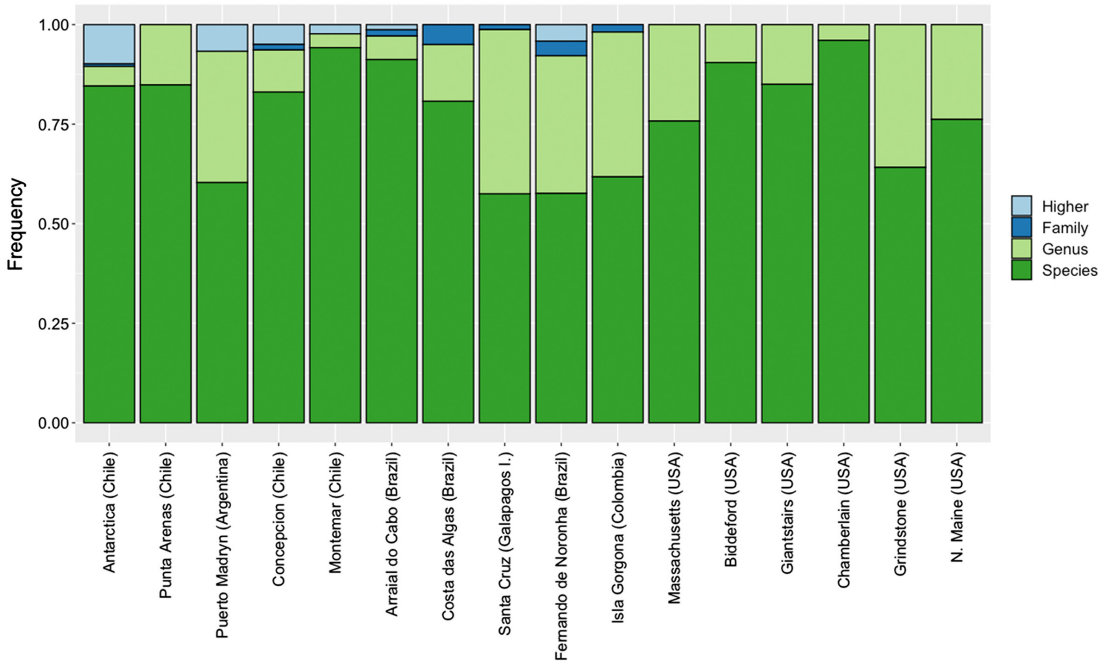

FIGURE S1. Taxonomic rank distribution of survey records collected per locality.

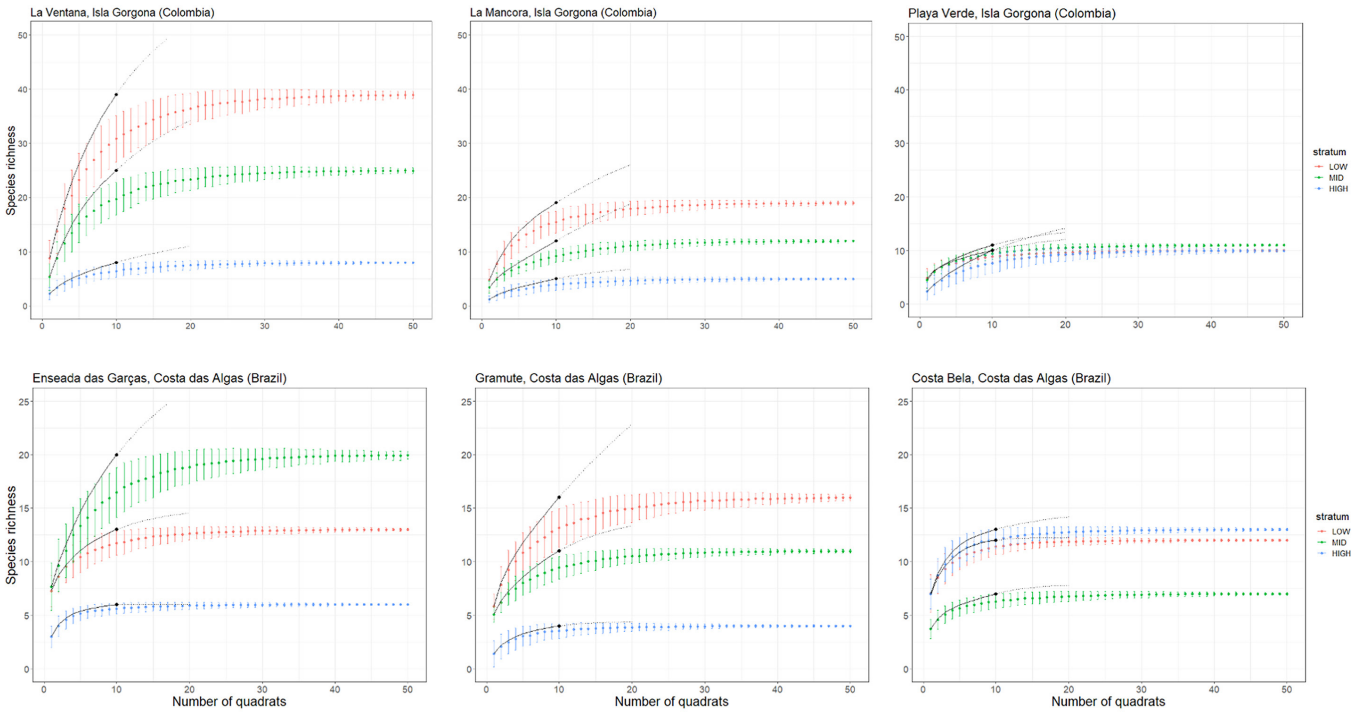

FIGURE S2. Simulated species richness (colored symbols) versus number of samples (quadrats) and corresponding rarefaction curves for three example sites in Colombia and Brazil. Interpolated and extrapolated species richness are shown with continuous and dotted lines, respectively, per tidal stratum. Dots represent actual number of samples collected. Simulated species richness corresponds to the cumulative number of species observed in randomly selected quadrats from each survey (single quadrat through a total of 50, with replacement), with over 1,000 iterations. Each colored dot and error bar thus corresponds to the mean and standard deviation of richness values averaged over the 1,000 iterations versus increasing sampling effort.

TABLE S1. Sampling effort (# quadrats) and corresponding number of observations (# records) collected at each locality and site. A record is defined as a single observation of an organism registered as percent cover or abundance value. The number of species (# spp) is a count of observed taxa within each stratum (i.e., species richness). The last column (Total spp) contains the number of taxa found across all sampled strata. The notation "ns" indicates "not surveyed" or strata where samples were not collected.

Country	Locality	Site	Date	Longitude	Latitude	# Quadrats High Tide	# Quadrats Mid Tide	# Quadrats Low Tide	# Records High Tide	# Records Mid Tide	# Records Low Tide	Total Quadrats	Total Records	# spp High Tide	# spp Mid Tide	# spp Low Tide	Total spp
Argentina	Puerto Madryn	Punta Cuevas	11/5/2018	−65.002	−42.780	10	10	10	23	69	50	30	142	6	11	13	20
	Puerto Madryn	Punta Este	10/25/2018	−64.953	−42.785	10	10	10	31	53	111	30	195	5	7	24	26
	Puerto Madryn	Punta Loma	10/26/2018	−64.902	−42.811	10	10	10	23	74	118	30	215	4	12	25	29
Brazil	Arraial Do Cabo	Atalaia	12/5/2018	−42.010	−22.986	10	10	10	49	64	71	30	184	17	17	17	21
	Arraial Do Cabo	Atalaia	3/7/2019	−42.010	−22.986	10	10	10	215	0	0	30	215	19	0	0	19
	Arraial Do Cabo	Fortaleza	11/21/2018	−42.013	−22.971	10	10	10	37	62	108	30	207	4	19	22	22
	Arraial Do Cabo	Fortaleza	2/19/2019	−42.013	−22.971	10	10	10	28	58	105	30	191	19	11	22	24
	Arraial Do Cabo	Prainha	11/8/2018	−42.024	−22.954	10	10	10	24	45	78	30	147	3	19	18	22
	Arraial Do Cabo	Prainha	2/18/2019	−42.024	−22.954	10	10	10	28	77	102	30	207	14	14	18	21
	Costa Das Algas	Costa Bela	10/25/2018	−40.175	−20.073	10	10	10	70	37	69	30	176	13	7	12	22
	Costa Das Algas	Enseada Das Garças	10/24/2018	−40.164	−20.037	10	10	10	30	76	73	30	179	6	20	13	27
	Costa Das Algas	Gramuté	10/9/2018	−40.134	−19.966	10	10	10	14	51	58	31	123	6	13	15	24
	Fernando De Noronha	Leao	2/25/2019	−32.441	−3.871	10	10	10	12	33	16	30	61	3	4	3	5
	Fernando De Noronha	Air France	2/21/2019	−32.400	−3.832	10	10	10	10	17	31	30	58	1	3	7	7
	Fernando De Noronha	Boldro	2/22/2019	−32.432	−3.846	10	10	10	10	14	24	30	48	1	4	7	8
	Fernando De Noronha	Caieiras	2/24/2019	−32.398	−3.836	8	8	10	11	15	24	26	50	2	6	6	7
Chile	Antarctica	Artigas	2/19/2019	−58.879	−62.186	9	10	10	20	26	37	29	83	4	4	11	16
	Antarctica	Punta Cristian	2/18/2019	−58.949	−62.199	10	10	10	12	22	45	30	79	3	4	7	10
	Concepcion	Cocholgue Norte	9/26/2018	−72.979	−36.595	10	10	10	35	59	111	30	205	9	15	26	37
	Concepcion	Cocholgue Sur	10/8/2018	−72.981	−36.609	10	10	10	24	68	64	30	156	6	16	21	29
	Concepcion	Dichato	11/19/2018	−72.934	−36.539	10	10	10	29	57	55	30	141	5	14	16	23
	Punta Arenas	Puerto De Hambre	10/5/2018	−70.931	−53.611	10	10	10	24	49	59	30	132	8	13	18	28
	Montemar	Viña Del Mar	11/14/2018	−71.549	−32.959	10	10	10	35	78	60	30	173	9	26	22	41
Colombia	Isla Gorgona	La Mancora	10/13–14/2018	−78.198	2.957	9	10	10	12	34	48	29	94	6	15	22	27
	Isla Gorgona	La Ventana	10/10–11/2018	−78.203	2.934	10	10	10	22	54	88	30	164	8	30	38	56
	Isla Gorgona	Playa Verde	10/12 & 14/2018	−78.198	2.948	8	10	10	23	45	48	28	116	10	10	11	23
Ecuador	Santa Cruz	Charles Darwin Foundation	3/27/2019	−90.304	−0.743	10	10	10	5	11	11	30	27	3	5	6	10
	Santa Cruz	Ratonera	3/28/2019	−90.302	−0.744	10	10	10	2	6	16	30	24	2	3	5	7
	Santa Cruz	Tortuga Bay	3/29/2019	−90.339	−0.765	10	10	10	0	10	19	30	29	0	5	8	8
USA	Maine	Hamilton Cove	7/13/2018	−67.010	44.788	5	5	ns	41	42	ns	10	83	14	16	ns	17
	Maine	Moose Cove	7/15/2018	−67.099	44.732	ns	10	ns	ns	64	ns	10	64	ns	20	ns	20
	Maine	Chamberlain	7/18/2018	−69.476	43.884	5	5	ns	42	34	ns	20	76	14	12	ns	17
	Maine	Giantstairs	7/16/2018	−69.992	43.726	5	5	ns	29	51	ns	10	80	12	15	ns	19
	Maine	Biddeford	7/18/2018	−70.343	43.440	5	5	ns	35	28	ns	10	63	12	12	ns	13
	Maine	Grindstone	8/13/2018	−68.093	44.371	5	5	ns	21	32	ns	10	53	6	7	ns	8
	Massachusetts	Marblehead	7/17/2018	−70.844	42.507	5	5	ns	37	32	ns	10	69	10	8	ns	10
	Massachusetts	Pumphouse	7/16/2018	−70.907	42.417	10	10	ns	28	31	ns	20	59	8	8	ns	9

TABLE S2. Minimum number of quadrats required to cover 90 % of taxa richness at surveyed sites using coverage-based stopping. Buffer values correspond to the number of extra quadrats that should be collected to enable the detection of new species in repeated surveys, and each is equivalent to the rounded 20% of the minimum sampling value. The notation "ns" indicates "not surveyed" or strata where samples were not collected.

Country	Locality	Site	Longitude	Latitude	Minimum Number of Quadrats (+ Buffer)		
					High Tide	Mid Tide	Low Tide
Argentina	Puerto Madryn	Punta Cuevas	–65.00	–42.78	5 (1)	3 (1)	8 (2)
	Puerto Madryn	Punta Este	–64.95	–42.79	2 (1)	2 (1)	4 (1)
	Puerto Madryn	Punta Loma	–64.90	–42.81	2 (1)	2 (1)	5 (1)
Brazil	Arraial Do Cabo	Atalaia	–42.01	–22.99	3 (1)	1 (1)	1 (1)
	Arraial Do Cabo	Fortaleza	–42.01	–22.97	1 (1)	3 (1)	2 (1)
	Arraial Do Cabo	Prainha	–42.02	–22.95	1 (1)	5 (1)	3 (1)
	Costa Das Algas	Costa Bela	–40.18	–20.07	4 (1)	3 (1)	3 (1)
	Costa Das Algas	Enseada Das Garças	–40.16	–20.04	3(1)	10 (2)	3 (1)
	Costa Das Algas	Gramuté	–40.13	–19.97	5 (1)	5 (1)	18 (4)
	Fernando De Noronha	Leao	–32.44	–3.87	1 (1)	2 (1)	2 (1)
	Fernando De Noronha	Air France	–32.40	–3.83	1 (1)	3 (1)	4 (1)
	Fernando De Noronha	Boldro	–32.43	–3.85	1 (1)	8 (2)	8 (2)
	Fernando De Noronha	Caieiras	–32.40	–3.84	3 (1)	7 (2)	5(1)
Chile	Antarctica	Artigas	–58.88	–62.19	3 (1)	2 (1)	7 (2)
	Antarctica	Punta Cristian	–58.95	–62.20	1 (1)	3 (1)	1 (1)
	Concepcion	Cocholgue Norte	–72.98	–36.60	5 (1)	18 (4)	6 (1)
	Concepcion	Cocholgue Sur	–72.98	–36.61	5 (1)	5 (1)	19 (4)
	Concepcion	Dichato	–72.93	–36.54	2 (1)	5 (1)	8 (2)
	Punta Arenas	Puerto De Hambre	–70.93	–53.61	8 (2)	5 (1)	10 (2)
	Montemar	Viña Del Mar	–71.55	–32.96	6 (1)	20 (4)	18 (4)
Colombia	Isla Gorgona	La Mancora	–78.20	2.96	13(3)	31 (6)	24 (5)
	Isla Gorgona	La Ventana	–78.20	2.93	14(3)	25 (5)	21 (4)
	Isla Gorgona	Playa Verde	–78.20	2.95	18 (4)	6 (1)	4 (1)
Ecuador	Santa Cruz	Charles Darwin Foundation	–90.30	–0.74	11 (2)	16(2)	16 (3)
	Santa Cruz	Ratonera	–90.30	–0.74	12 (2)	11(2)	5 (1)
	Santa Cruz	Tortuga Bay	–90.34	–0.77	ns	10 (2)	10 (2)
USA	Maine	Hamilton Cove	–67.01	44.79	7 (2)	16 (3)	ns
	Maine	Moose Cove	–67.10	44.73	ns	11(2)	ns
	Maine	Chamberlain	–69.48	43.88	7 (2)	7 (2)	ns
	Maine	Giantstairs	–69.99	43.73	15 (3)	6(1)	ns
	Maine	Biddeford	–70.34	43.44	11 (2)	9 (2)	ns
	Maine	Grindstone	–68.09	44.37	4 (1)	4 (1)	ns
	Massachusetts	Marblehead	–70.84	42.51	5(1)	4 (1)	ns
	Massachusetts	Pumphouse	–70.91	42.42	5 (1)	5(1)	ns

TABLE S3. References used for delimiting intertidal zones along sampled sites.

GEOGRAPHICAL REGION OR SITE	REFERENCE
Arraial do Cabo, RJ, Brazil	Coutinho, R. 1995. Avaliação crítica das causas da zonação dos organismos bentônicos em costões rochosos. *Oecologia Brasiliensis* 1:259–271 (available only in Portuguese).
Fernando de Noronha, PE, Brazil	Eston, V.R., A.E. Migotto, E.C. Oliveira-Filho, S.A. Rodrigues, and J.C. Freitas. 1986. Vertical distribution of the benthic marine organisms on rocky coasts of the Fernando de Noronha Archipelago (Brazil). *Boletim do Instituto Oceanográfico* 34:37–53, https://doi.org/10.1590/S0373-55241986000100004.
Northern Chile	Guiler, E.R. 1959. Intertidal belt-forming species on the rocky coasts of northern Chile. Pp. 33–58 in *Papers and Proceedings of the Royal Society of Tasmania, vol. 93*. Aguilera, M.A., J.A. Aburto, L. Bravo, B.R. Broitman, R.A. García, C.F. Gaymer, S. Gelcich, B.A. López, V. Montecino, A. Pauchard, and others. 2019. Chile: Environmental status and future perspectives. Pp. 673–702 in *World Seas: An Environmental Evaluation*, 2nd ed. Academic Press, https://doi.org/10.1016/B978-0-12-805068-2.00046-2.
Central Chile	Santelices, B. 1981. Perspectiva de investigación en estructura y dinámica de comunidades intermareales rocosas de Chile Central. I. Cinturones de macroalgas. *Medio Ambiente* 5:175–189. Santelices, B., J.C. Castilla, J. Cancino, and P. Schmiede. 1980. Comparative ecology of *Lessonia nigrescens* and *Durvillaea antarctica* (Phaeophyta) in Central Chile. *Marine Biology* 59:119–132, https://doi.org/10.1007/BF00405461. Aguilera, M.A., J.A. Aburto, L. Bravo, B.R. Broitman, R.A. García, C.F. Gaymer, S. Gelcich, B.A. López, V. Montecino, A. Pauchard, and others. 2019. Chile: Environmental status and future perspectives. Pp. 673–702 in *World Seas: An Environmental Evaluation*, 2nd ed. Academic Press, https://doi.org/10.1016/B978-0-12-805068-2.00046-2. Castilla, J.C. 1974. *Guía para la observación del ambiente litoral*. Editora Nacional Gabriela Mistral, 65 pp. Oliva, D., and J.C. Castilla. 1992. Guía para el reconocimiento y morfometría de 10 especies del género Fissurella comunes en la pesquería y conchales indígenas de Chile central y sur. *Gayana* 56(3-4):77–108. Alveal, K. 1971. El ambiente costero de Montemar y su expresión biológica. *Revista de Biología Marina* 14:85–119.
Southern Chile	Benedetti-Cecchi, L., and F. Cinelli. 1997. Spatial distribution of algae and invertebrates in the rocky intertidal zone of the Strait of Magellan: Are patterns general? *Polar Biology* 18(5):337–343, https://doi.org/10.1007/s003000050197. Ríos, C., and E. Mutschke. 1999. Community structure of intertidal boulder-cobble fields in the Straits of Magellan, Chile. *Scientia Marina* 63(S1):193–201.
Gorgona Island, Colombian Pacific	Londoño-Cruz et al. 2014. Distribution of macroinvertebrates on intertidal rocky shores in Gorgona Island, Colombia (Tropical Eastern Pacific). *Revisita de Biología Tropical* 62(Suppl. 1):189–198.
Galapagos Islands	Vinueza, L.R., G.M. Branch, M.L. Branch, and R.H. Bustamante. 2006. Top-down herbivory and bottom-up El Niño effects on Galápagos rocky-shore communities. *Ecological Monographs* 76:111–131. Vinueza, L.R., B.A. Menge, D. Ruiz, and D.M. Palacios. 2014. Oceanographic and climatic variation drive top-down/bottom-up coupling in the Galapagos intertidal meta-ecosystem. *Ecological Monographs* 84(3):411–434, https://doi.org/10.1890/13-0169.1. Vinueza, L., and M. Flores. 2002. Comunidades intermareales rocosas. Pp. 98–118 in *Reserva Marina de Galápagos*. Linea Base de la Biodiversidad. Fundación Charles Darwin y Servicio Parque Nacional de Galápagos, Santa Cruz.
Gulf of Maine, USA	Menge, B.A., and J.P. Sutherland. 1987. Community regulation: Variation in disturbance, competition, and predation in relation to environmental stress and recruitment. *The American Naturalist* 130:730–757, https://doi.org/10.1086/284741. Sorte, C.J.B., V.E. Davidson, M.C. Franklin, K.M. Benes, M.M. Doellman, R.J. Etter, R.E. Hannigan, J. Lubchenco, and B.A. Menge. 2017. Long-term declines in an intertidal foundation species parallel shifts in community composition. *Global Change Biology* 23:341–352, https://doi.org/10.1111/gcb.13425.
Costa das Algas, ES, Brazil	Mazzuco, A.C.A., P.S. Stelzer, and A.F. Bernardino. F. 2020. Substrate rugosity and temperature matters: patterns of benthic diversity at tropical intertidal reefs in the SW Atlantic. *PeerJ* 8:e8289, https://doi.org/10.7717/peerj.8289.
Atlantic Patagonia, Argentina	Miloslavich, P., J.J. Cruz-Motta, A. Hernández, C. Herrera, E. Klein, F. Barros, G. Bigatti, M Cárdenas, A. Carranza, and A. Flores. 2016a. Benthic assemblages in South American intertidal rocky shores: Biodiversity, services, and threats. *Marine Benthos* 83. Raffo, M.P., V. Lo Russo, and E. Schwindt. 2014. Introduced and native species on rocky shore macroalgal assemblages: Zonation patterns, composition and diversity. *Aquatic Botany* 112:57–65, https://doi.org/10.1016/j.aquabot.2013.07.011.