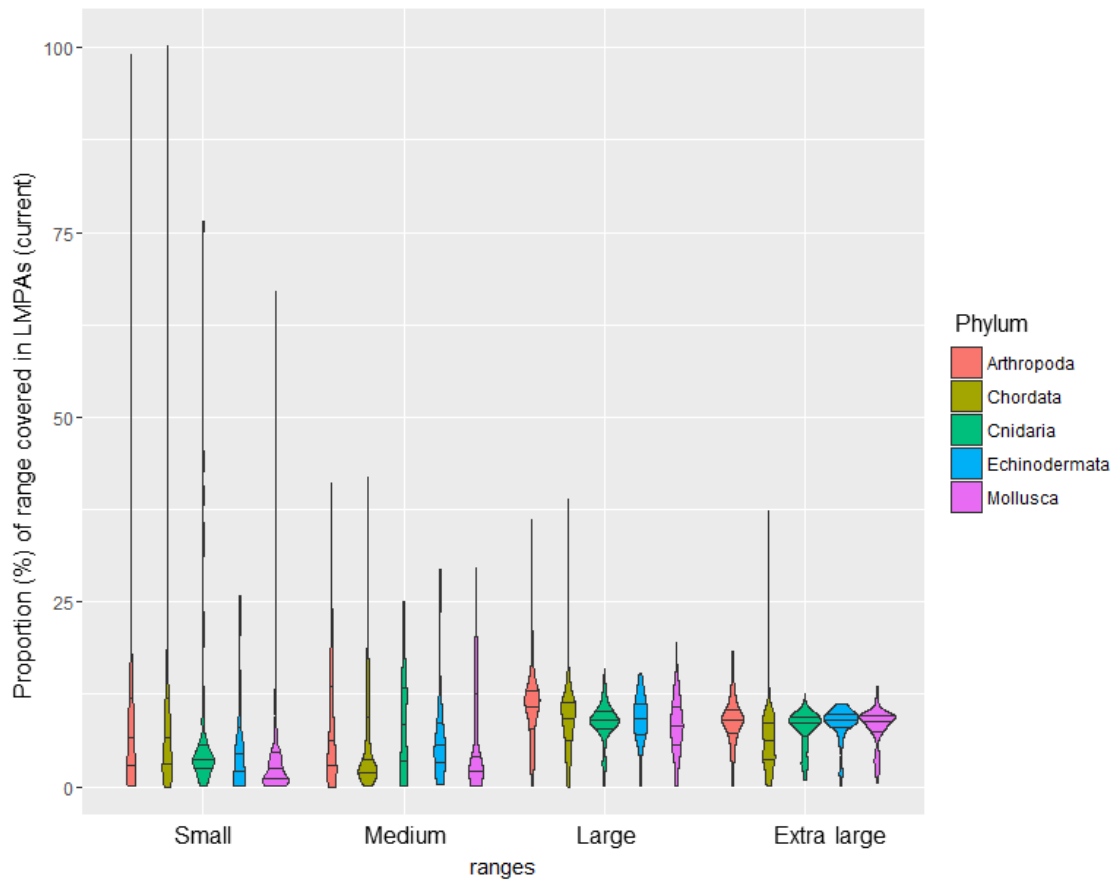


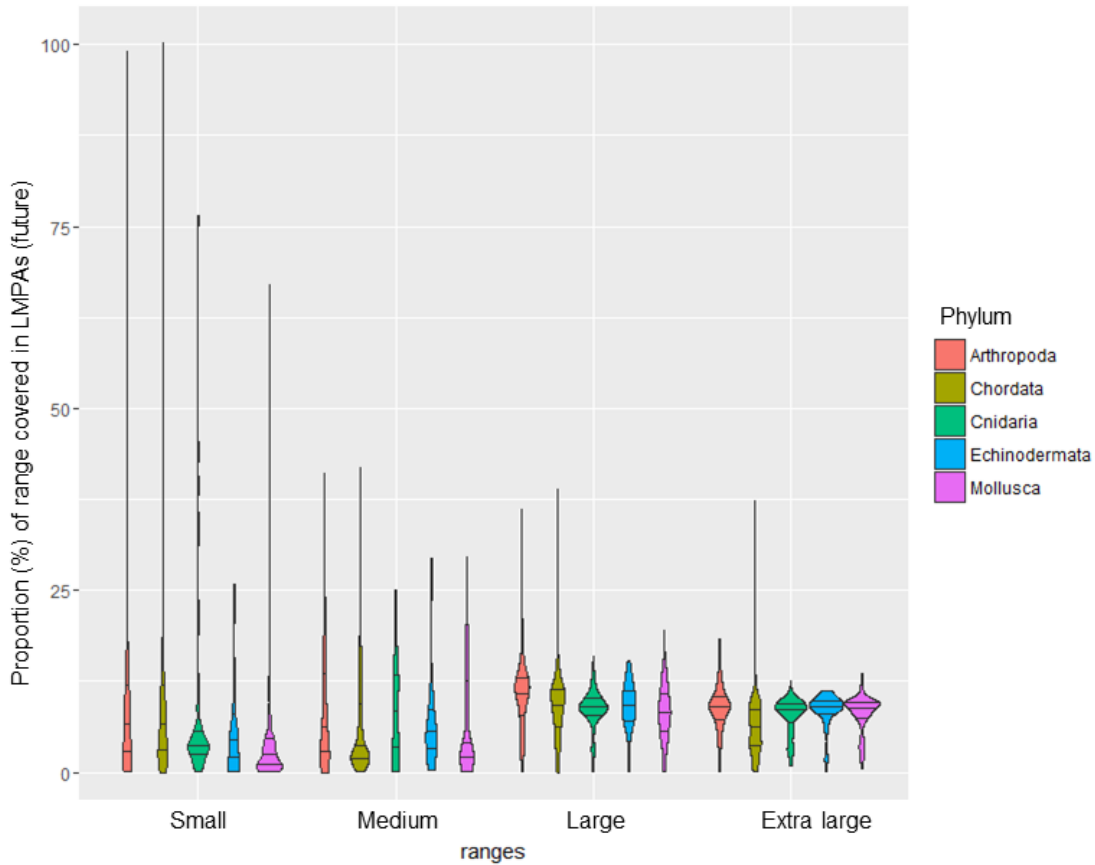
**Supplementary information for:**

**Large marine protected areas represent biodiversity now and under climate change.**

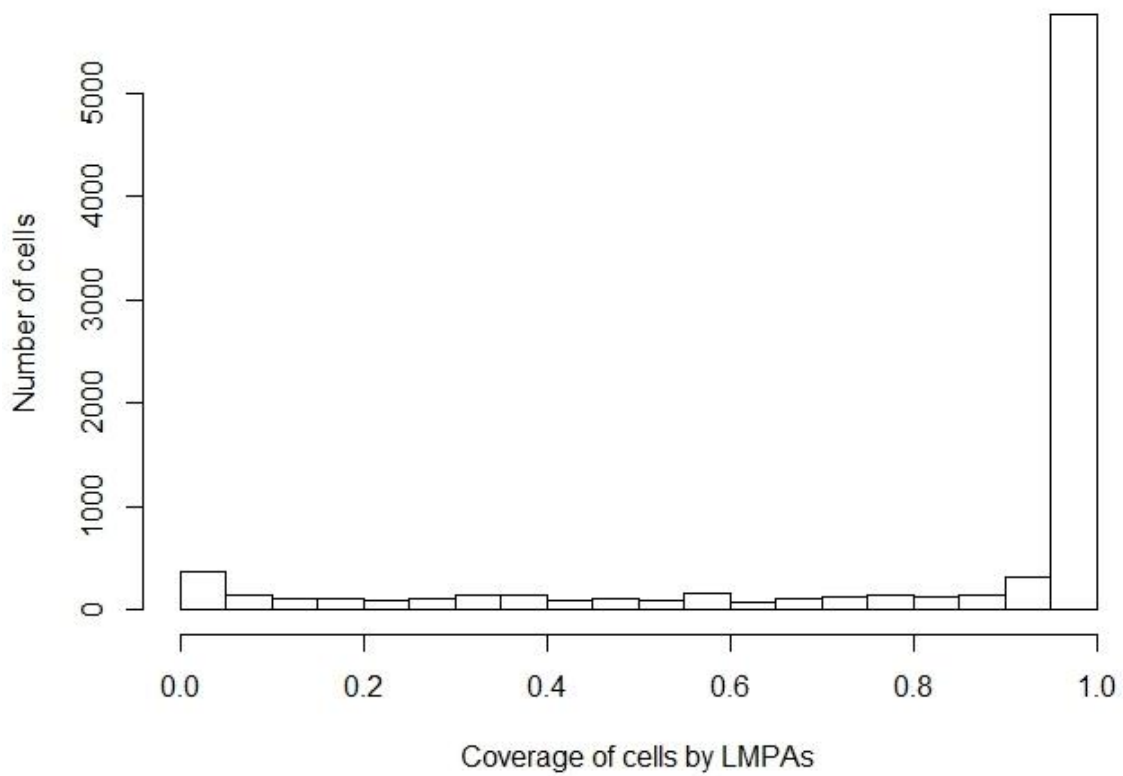
T.E. Davies, S.M. Maxwell, K. Kaschner, C. Garilao, N.C. Ban



**Supplementary Fig. 1. The percentage of species range currently represented in designated LMPAs by distributional range category: small (<1,570,000 km<sup>2</sup>), medium (1,570,000 - 4,490,000 km<sup>2</sup>), large (4,490,000 - 8,270,000 km<sup>2</sup>), extra large (>8,270,000 km<sup>2</sup>), shown for the five largest phyla. Lines within the violin plots indicate quantiles (0.25, 0.5, 0.75).**



**Supplementary Fig. 2. The percentage of future species range projected to be represented in designated LMPAs in the year 2100 by distributional range category:** small (<1,570,000 km<sup>2</sup>), medium (1,570,000 - 4,490,000 km<sup>2</sup>), large (4,490,000 - 8,270,000 km<sup>2</sup>), extra large (>8,270,000 km<sup>2</sup>), shown for the five largest phyla. Lines within the violin plots indicate quantiles (0.25, 0.5, 0.75).



**Supplementary Fig. 3. Histogram of the number cells that contain LMPAs and the proportion of ocean area within each cell that is covered by LMPAs.**

**Supplementary Table 1.** Names of large marine protected areas used in the study (shown in Fig. 1). Designated large marine protected areas are numbered, and proposed large marine protected areas are preceded with ‘P’.

<b>Number</b>	<b>Name of large marine protected area</b>
1	Greenland National Park
2	Svalbard North and South Nature Reserves
3	Franz Josef Land
4	Pelagos Sanctuary
5	British Indian Ocean Territory Marine Protected Area (Chagos)
6	Gloriosos Islands & Marine Park of Mayotte
7	Prince Edward Islands Marine Protected Area
8	Heard Island and McDonald Islands Marine Reserve
9	Papahānaumokuākea Marine National Monument
10	Marianas Trench Marine National Monument
11	Pacific Remote Islands Marine National Monument
12	Palau National Marine Sanctuary
13	Phoenix Islands Protected Area
14	Rose Atoll Marine National Monument
15	Savu Sea (Tirosa Batek) Marine National Park
16	Argo-Rowley Terrace, Kimberley, & Oceanic Shoals Commonwealth Marine Reserves
17	Gascoyne Commonwealth Marine Reserve
18	Abrolhos Commonwealth Marine Reserve
19	South-west Corner Commonwealth Marine Reserve
20	Great Australian Bight Commonwealth Marine Reserve
21	Western Eyre Commonwealth Marine Reserve
22	Tasman Fracture Commonwealth Marine Reserve
23	Freycinet Commonwealth Marine Reserve
24	Great Barrier Reef Marine Park
25	Coral Sea Commonwealth Marine Reserve
26	Natural Park of the Coral Sea
27	Central Eastern Commonwealth Marine Reserve
28	Lord Howe Commonwealth Marine Reserve
29	Norfolk Commonwealth Marine Reserve
30	Norfolk Deep Benthic Protection Area
31	Marae Moana Cook Islands (Cook Islands Marine Park)
32	Kermadec Benthic Protection Area
33	Challenger South Benthic Protection Area
34	Hikurangi Deep Benthic Protection Area
35	Fiorland Transect Benthic Protection Area
36	Arrow Plateau Benthic Protection Area
37	Antipodes Transect Benthic Protection Area

38	Sub-Antarctic Deep Benthic Protection Area
39	Macquarie Island Commonwealth Marine Reserve
40	Galapagos Marine Reserve
41	Pitcairn Islands Marine Reserve
42	Motu Motivo Hiva Marine Park
43	Charlie-Gibbs North High Seas Marine Protected Area
44	Charlie-Gibbs South High Seas Marine Protected Area
45	Mid-Atlantic Ridge North of the Azores (MARNA)
46	Dominican Republic Marine Mammal Sanctuary
47	Seaflower Marine Protected Area
48	South Georgia and South Sandwich Islands Marine Protected Area
49	South Orkney Islands Southern Shelf Marine Protected Area
P1	East Antarctic
P2	Ross Sea

**Supplementary Table 2.** Overview of representation for all marine species for both current and future scenarios in designated (and proposed) LMPAs.

Taxon	CURRENT			FUTURE			Difference in median proportion of range covered between current and future (%)	Mean loss in distributional range size by year 2100
	N (including proposed LMPAs)	Median distribution range (km <sup>2</sup> ) (including proposed LMPAs)	Median proportion of distribution range covered in designated LMPAs (%) (including proposed LMPAs)	N (including proposed LMPAs)	Median distribution range (km <sup>2</sup> ) (including proposed LMPAs)	Median proportion of distribution range covered in designated LMPAs (%) (including proposed LMPAs)		
<b>All</b>	<b>11,800</b> (11,829)	<b>4,588,869</b> (4,562,337)	<b>7.0</b> (7.3)	<b>11,611</b> (11,644)	<b>3,292,972</b> (3,275,649)	<b>8.3</b> (8.8)	<b>1.3</b> (1.5)	<b>23.8</b>
Chordata	7,685 (7,699)	4,154,166 (4,132,870)	6.5 (6.7)	7,575 (7,590)	2,942,824 (2,934,118)	7.6 (8.0)	1.1 (1.3)	25.2
<i>Actinopterygii</i>	6,696 (6,710)	4,237,179 (4,227,795)	6.8 (6.9)	6,608 (6,623)	2,974,780 (2,963,520)	8.1 (8.3)	1.3 (1.4)	24
<i>Elasmobranchii</i>	441 (442)	2,433,839 (2,433,840)	5.3 (5.4)	427 (427)	1,954,621 (1,954,621)	6.0 (6.1)	0.7 (0.7)	39
<i>Ascidiacea</i>	269 (269)	3,996,440 (3,996,440)	5.6 (8.3)	267 (267)	3,264,213 (3,264,213)	6.3 (10.6)	0.7 (2.3)	15.7
<i>Aves</i>	114 (114)	2,685,333 (2,685,333)	3.6 (4.0)	111 (111)	2,543,996 (2,543,996)	3.2 (3.3)	-0.4 (-0.7)	29.5
<i>Mammalia</i>	84 (84)	28,283,718 (28,283,718)	3.7 (4.3)	83 (83)	21,669,816 (21,669,816)	4.0 (4.3)	0.3 (0.0)	27.4
<i>Reptilia</i>	27 (27)	7,153,130 (7,153,130)	7.2 (7.2)	27 (27)	5,712,917 (5,712,917)	7.2 (7.2)	0.0 (0.0)	24.8
Arthropoda	1650 (1665)	5,364,020 (5,322,156)	8.7 (9.5)	1,622 (1,639)	3,669,198 (3,597,670)	10.2 (11.7)	1.5 (2.2)	22.8
Mollusca	1380 (1380)	4,413,540 (4,413,540)	6.1 (6.3)	1,333 (1,333)	3,433,995 (3,433,995)	7.4 (7.5)	1.3 (1.2)	18.7
Cnidaria	626 (626)	6,258,470 (6,258,470)	8.5 (8.6)	623 (624)	4,954,089 (4,945,435)	10.4 (10.6)	1.9 (2.0)	23.4
Echinodermata	131 (131)	6,647,560 (6,647,560)	8.2 (8.8)	129 (129)	4,900,703 (4,900,703)	10.4 (11.0)	2.2 (2.2)	22.6

**Supplementary Table 3.** The representation of marine species distributional range in designated large marine protected areas by range category: small, medium, large, extra large, for both current and projected species distributions for the five largest phyla: Arthropoda, Chordata, Cnidaria, Echinodermata, and Mollusca.

Distribution range (km <sup>2</sup> )	Distribution	Phyla	N	Mean ( $\pm$ SD) representation	Median representation
<b>Small</b> (26,900-1,570,000)	Current	<b>ALL</b>	<b>2868</b>	<b>9.75 (<math>\pm</math>13.99)</b>	<b>5.04</b>
		Arthropoda	360	8.77 ( $\pm$ 11.52)	5.24
		Chordata	2071	11.00 ( $\pm$ 15.02)	6.12
		Cnidaria	83	6.78 ( $\pm$ 11.17)	3.66
		Echinoderm	19	5.67 ( $\pm$ 7.47)	4.43
	Mollusca	335	4.06 ( $\pm$ 7.63)	1.9	
	Future	<b>ALL</b>	<b>3706</b>	<b>9.57 (<math>\pm</math>14.00)</b>	<b>4.17</b>
		Arthropoda	459	8.59 ( $\pm$ 11.32)	4.93
		Chordata	2676	10.35 ( $\pm$ 14.74)	4.67
		Cnidaria	105	9.85 ( $\pm$ 14.37)	4.13
Echinoderm		28	7.97 ( $\pm$ 10.28)	5.78	
Mollusca	438	5.63 ( $\pm$ 11.03)	1.32		
<b>Medium</b> (1,570,000 – 4,490,000)	Current	<b>ALL</b>	<b>2868</b>	<b>6.64 (<math>\pm</math>7.13)</b>	<b>3.12</b>
		Arthropoda	378	8.09 ( $\pm$ 8.1)	5.24
		Chordata	1963	6.35 ( $\pm$ 7.01)	2.94
		Cnidaria	138	7.92 ( $\pm$ 2.62)	6.58
		Echinoderm	28	6.63 ( $\pm$ 6.76)	5.04
	Mollusca	361	6.23 ( $\pm$ 6.78)	2.65	
	Future	<b>ALL</b>	<b>3356</b>	<b>11.45 (<math>\pm</math>8.81)</b>	<b>10.51</b>
		Arthropoda	517	12.52 ( $\pm$ 8.78)	12.16
		Chordata	2247	11.10 ( $\pm$ 8.63)	10.21
		Cnidaria	179	14.29 ( $\pm$ 9.34)	15.37
Echinoderm		34	11.66 ( $\pm$ 7.63)	12.69	
Mollusca	379	10.69 ( $\pm$ 9.44)	7.48		
<b>Large</b> (4,490,000 – 8,270,000)	Current	<b>ALL</b>	<b>2868</b>	<b>8.94 (<math>\pm</math>3.86)</b>	<b>9.31</b>
		Arthropoda	472	10.29 ( $\pm$ 4.21)	11.04
		Chordata	1799	8.78 ( $\pm$ 3.84)	9.24
		Cnidaria	138	8.72 ( $\pm$ 2.62)	8.96
		Echinoderm	36	8.80 ( $\pm$ 3.62)	9.37
	Mollusca	327	8.10 ( $\pm$ 3.73)	8.22	
	Future	<b>ALL</b>	<b>2655</b>	<b>10.71 (<math>\pm</math>4.14)</b>	<b>11.02</b>
		Arthropoda	450	12.03 ( $\pm$ 3.91)	12.47
		Chordata	1539	10.66 ( $\pm$ 4.34)	11.06
		Cnidaria	274	10.55 ( $\pm$ 2.94)	10.84
Echinoderm		45	11.23 ( $\pm$ 3.33)	11.49	
Mollusca	347	9.26 ( $\pm$ 3.93)	9.33		
<b>Extra large</b> (8,270,000-431,000,000)	Current	<b>ALL</b>	<b>2868</b>	<b>6.89 (<math>\pm</math>3.36)</b>	<b>7.53</b>
		Arthropoda	440	8.76 ( $\pm$ 3.09)	8.96
		Chordata	1799	8.78 ( $\pm$ 3.84)	9.24
		Cnidaria	171	7.76 ( $\pm$ 2.50)	8.67
		Echinoderm	48	8.43 ( $\pm$ 2.43)	8.98
	Mollusca	357	8.06 ( $\pm$ 2.55)	8.85	
	Future	<b>ALL</b>	<b>1755</b>	<b>6.21 (<math>\pm</math>3.84)</b>	<b>5.52</b>
		Arthropoda	224	8.93 ( $\pm$ 4.24)	9.15
		Chordata	1223	5.27 ( $\pm$ 3.53)	4.35
		Cnidaria	68	6.91 ( $\pm$ 3.28)	7.02
Echinoderm		24	8.61 ( $\pm$ 3.77)	9.81	
Mollusca	216	8.27 ( $\pm$ 2.92)	9.13		

**Supplementary Table 4.** Comparison of the cumulative impacts (from: 19) within large marine protected areas and outside. The mean cumulative impact score is significantly higher within large marine protected areas (Welch's two sample t-test:  $p < 0.0001$ ,  $t = 5101.737$ ;  $df = 20,9127,53$ ). Total area of large marine protected areas: 15,826,452 km<sup>2</sup>.

<b>Cumulative impact score</b>	<b>Outside LMPAs</b>	<b>Inside LMPAs</b>
Very high (>8)	0.01	0.00
High (6-8)	0.26	0.02
Moderate (4-6)	18.85	17.19
Low (2-4)	43.75	64.17
Very low (<2)	37.13	18.62
<b>Mean (<math>\pm</math>SD)</b>	<b>2.43 (<math>\pm</math> 1.71)</b>	<b>3.11 (<math>\pm</math> 1.00)</b>