

Supplementary Figures

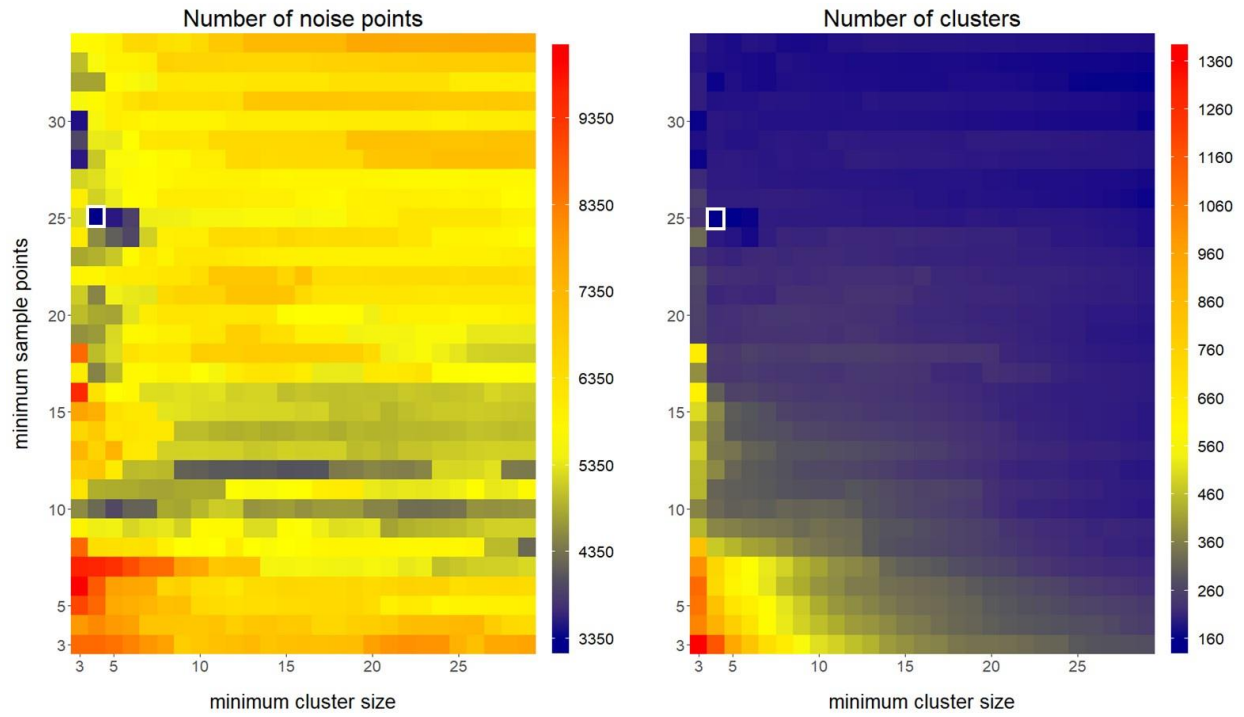


Figure S1. HDBSCAN parameter combination. Results of HDBSCAN run on aggregated VBD from April 1, 2012 to December 31, 2016 over varying parameter inputs (i.e., minimum cluster size and minimum sample points) in terms of resulting (a) number of VBD points not classified in any cluster (i.e., noise) and (b) unique clusters identified. The selected parameter combination for the final CFA determination is highlighted by the white square.

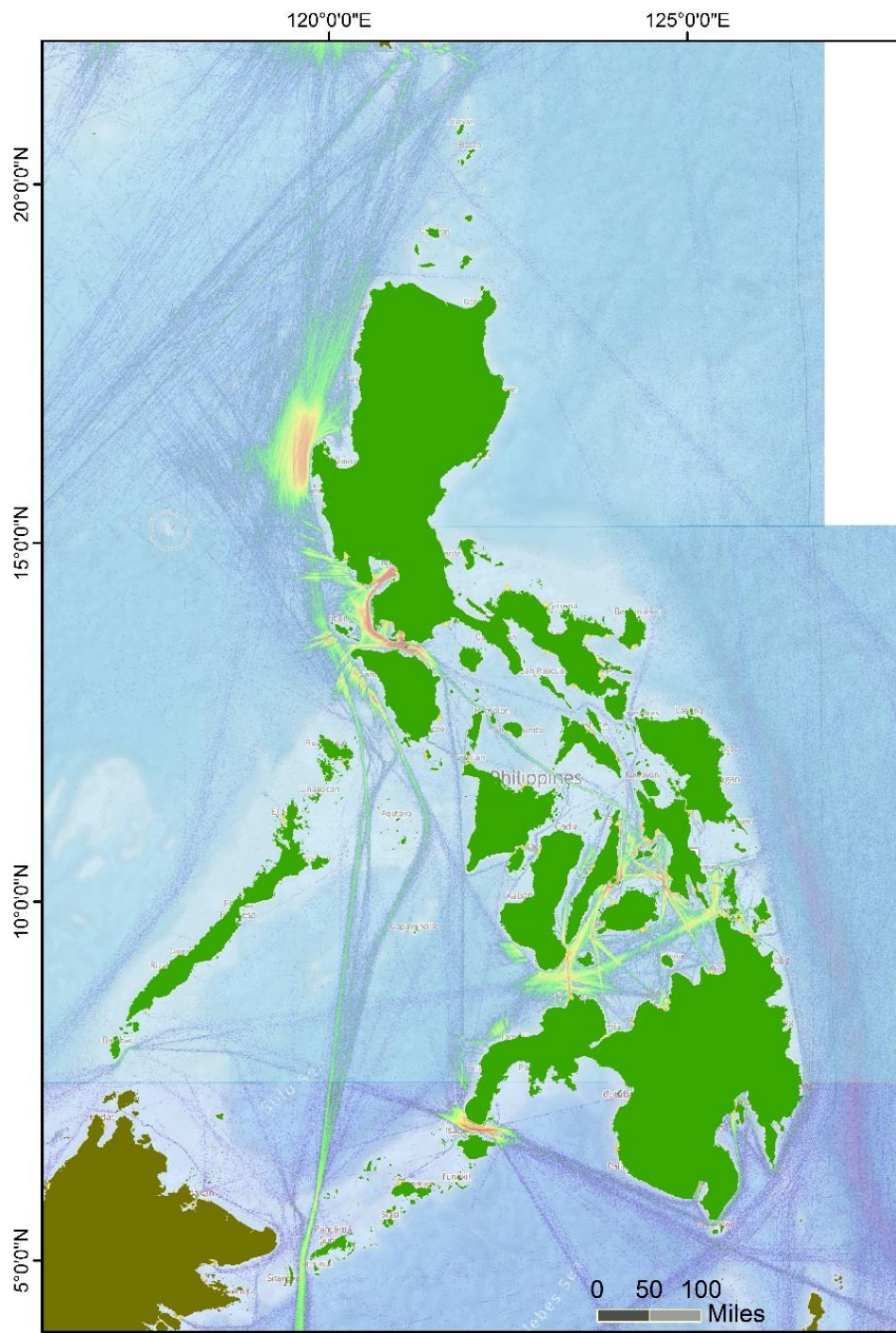


Figure S2. Marine traffic density map. Geo-referenced composite screenshot of vessel density map for 2015 from Marine Traffic website (<http://www.marinetraffic.com>; reproduced with permission).

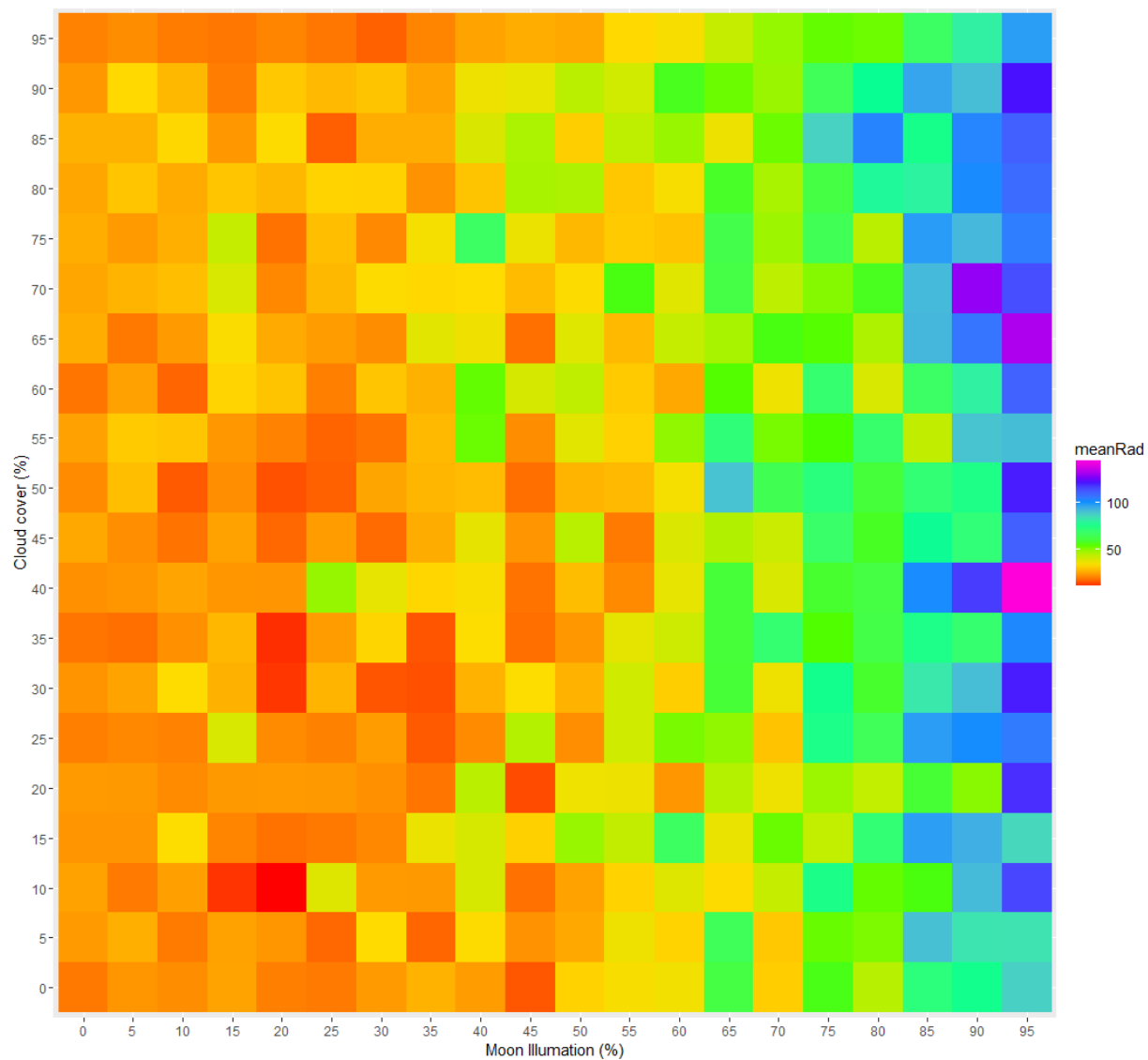


Figure S3. Mean radiance versus percentage cloud cover and moon illumination within CFAs. Nightly cloud cover data were obtained from the VIIRS Cloud Mask Intermediate Product (Kopp et al. 2014) and moon illumination fraction from the U.S. Naval Observatory website (<http://aa.usno.navy.mil/data/docs/MoonFraction.php>).

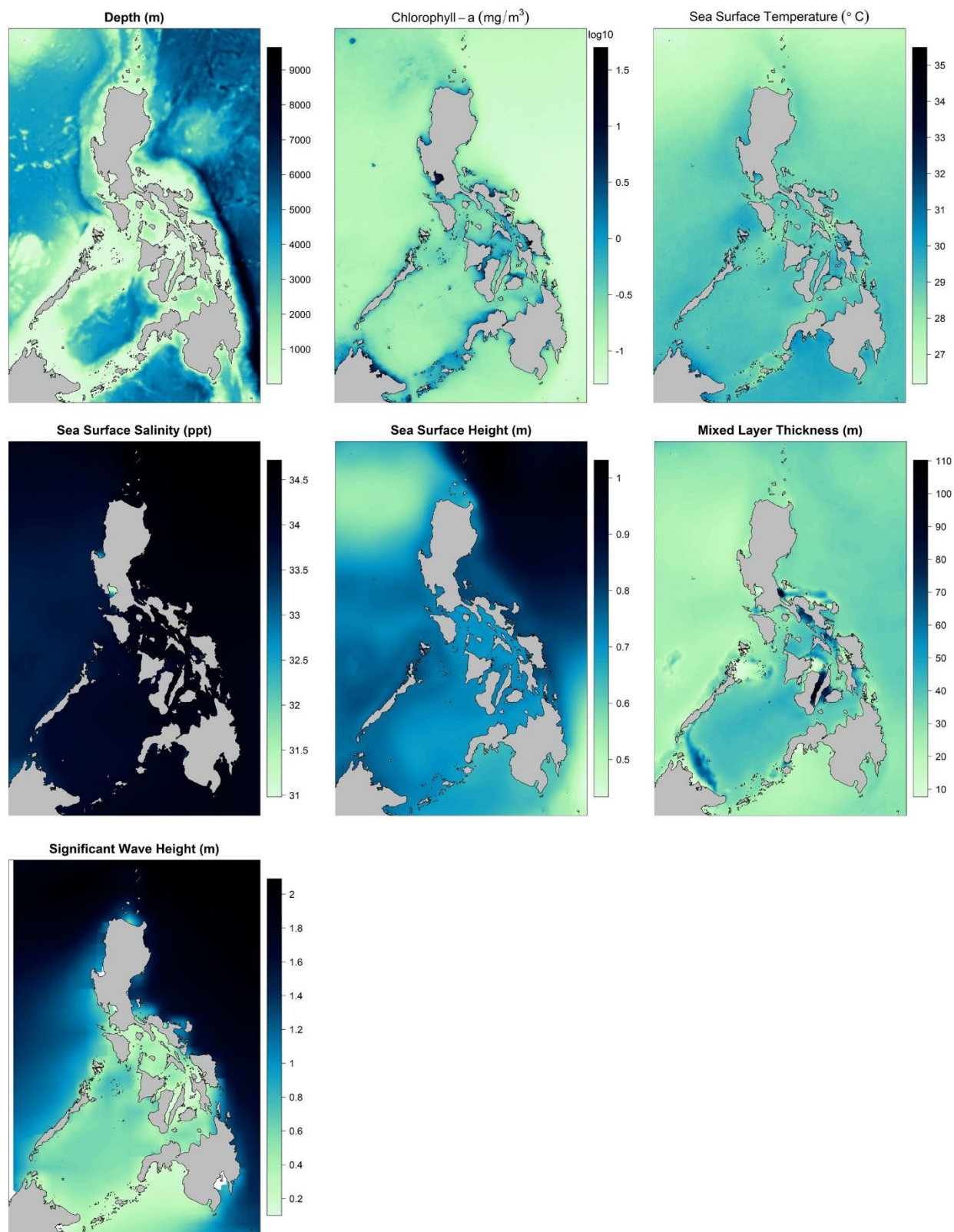


Figure S4. Mean climatology maps of environmental predictors (averaged from 2013 to 2016).

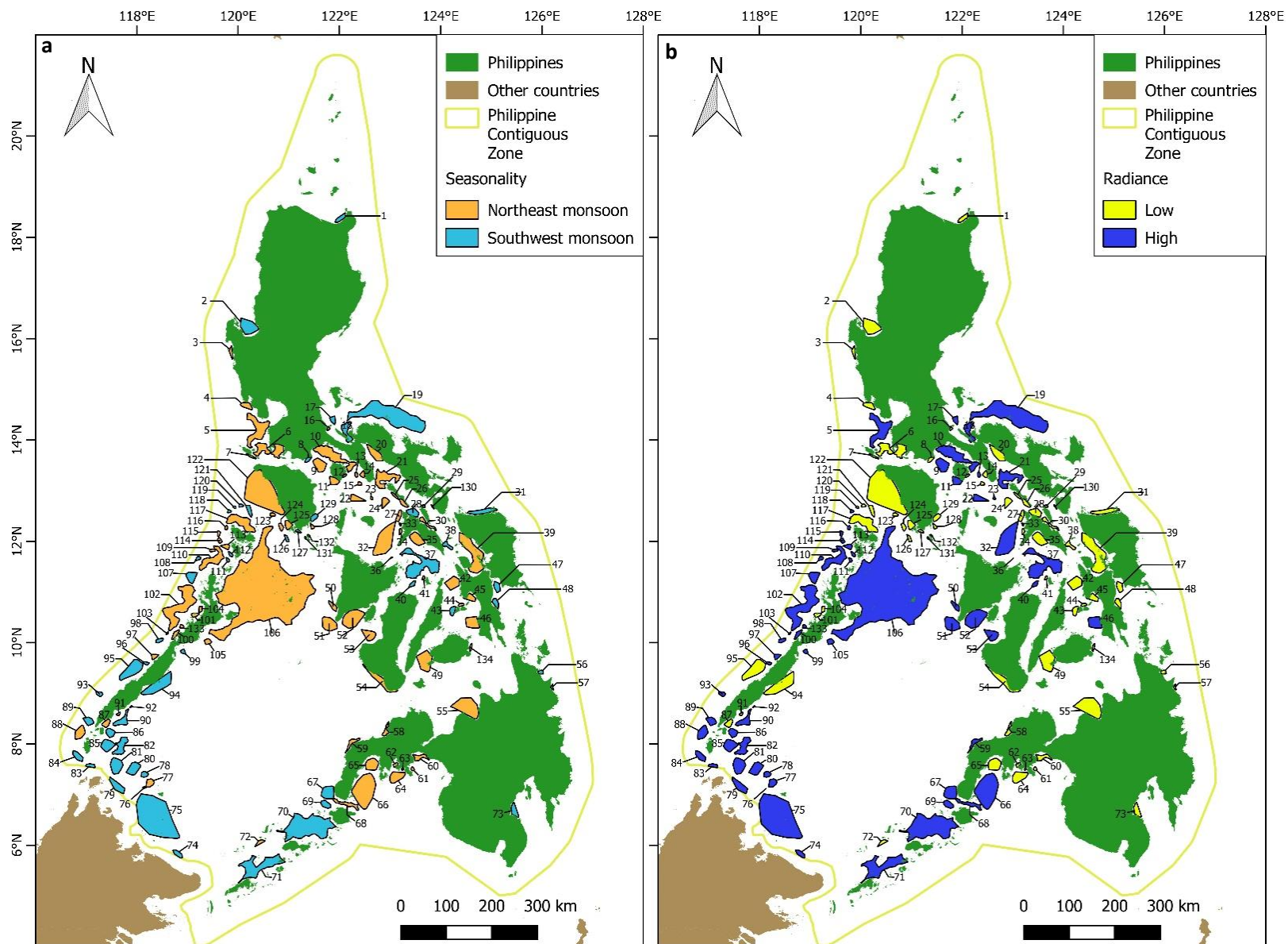


Figure S5. Core Fishing Areas mapped according to (a) seasonal and (b) radiance clusters. Based on results from Figures 4 and 5 in the main paper, respectively.

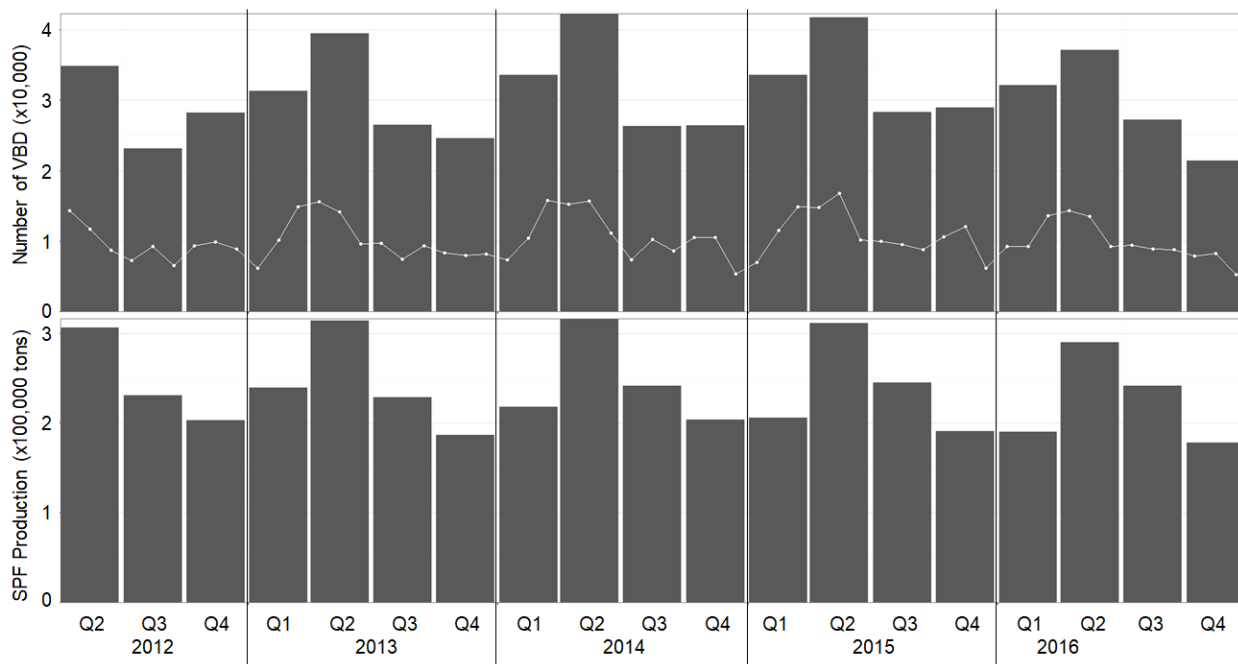


Figure S6. Comparison of VBD trend and reported quarterly production of small pelagic fishes.

Comparison aggregated VBD for all CFAs by quarter (bars) and month (line) (top chart) and total quarterly production of small pelagic fishes (i.e., sardines, scads, anchovies, mackerel, round herring, and squid) reported by the Philippines' Bureau of Agricultural Statistics (bottom).

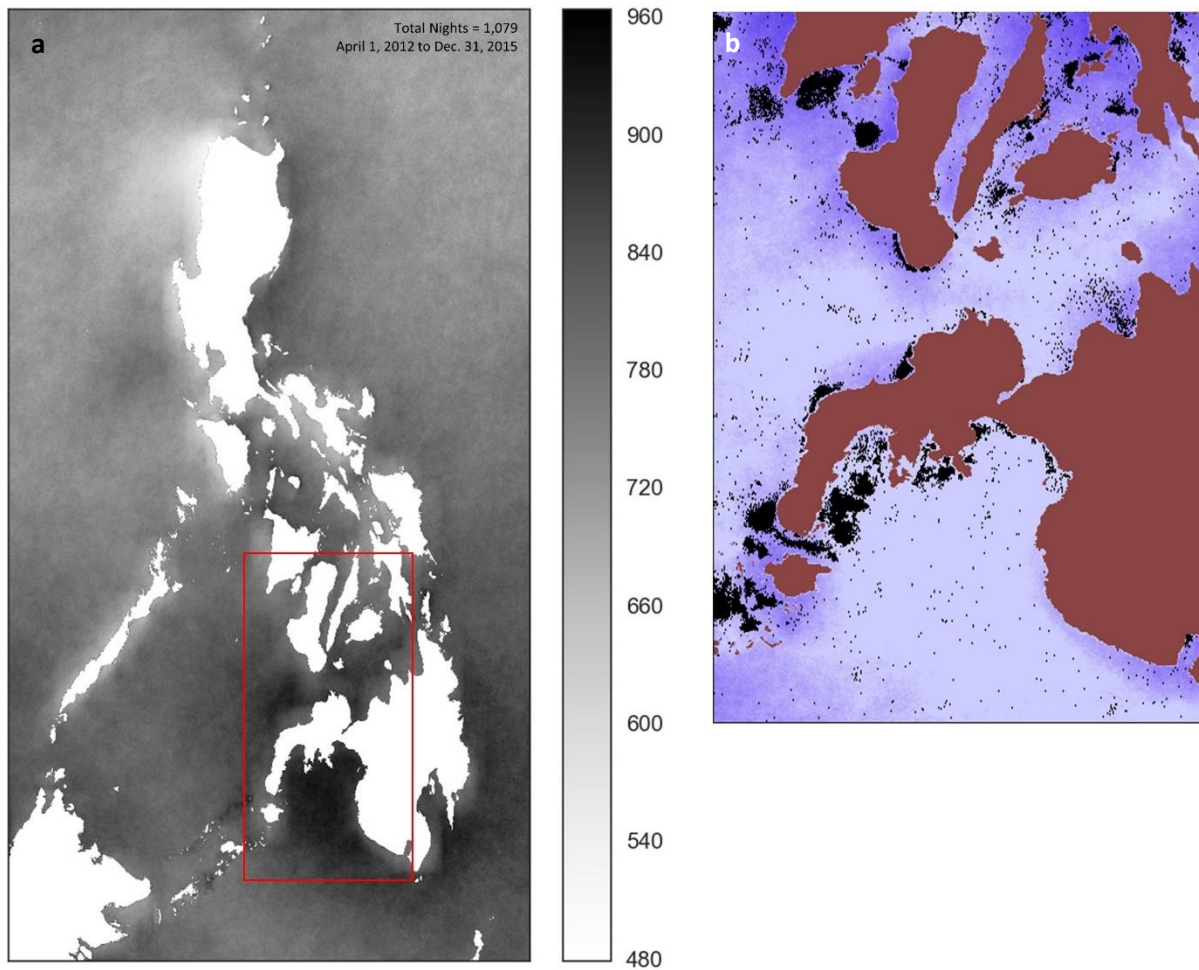


Figure S7. Spatial frequency of cloud cover in relation to VIIRS boat detection data. (a) Number of nights with “probably cloudy” and “confidently cloudy” quality flags from April 1, 2012 to Dec. 31, 2015 extracted from nightly VIIRS Cloud Mask Intermediate Product (IICMO) images and (b) selected part of the Philippines showing dense VIIRS Boat Detection despite the high frequency of nights with cloud cover compared to the rest of the country.

Table S1. Characteristics of Core Fishing Areas. MLT: mixed layer thickness based on density changes (meters); SST: sea surface temperature (°C); SSH: sea surface height; chl-a: surface chlorophyll-a.

ID	Core Fishing Area	Area (km ²)	Maximum lights per night	Mean lights per night	Mean radiance	Mean Depth (m)	Mean chl-a	Mean SST	Mean surface salinity	Mean SSH	Mean MLT (m)
1	Gonzaga, Cagayan	189	12	2.5	2.2	31	0.9	28.5	34.4	0.67	26
2	Lingayen Gulf	885	7	1.6	3.3	49	1.0	29.9	33.0	0.74	25
3	Dasol Bay	122	5	1.4	4.1	17	0.6	29.4	33.5	0.75	21
4	Subic Bay - Outside	248	13	3.5	7.8	69	0.5	29.3	33.6	0.74	20
5	Manila Bay - Outside	1436	67	9	48.6	173	0.8	29.1	33.7	0.74	25
6	Balayan Bay to VIP	1042	58	11.3	3.9	267	0.5	28.9	33.7	0.74	34
7	Looc, Occ. Mindoro	65	12	3.1	2.9	135	0.3	29.0	33.7	0.74	27
8	San Juan, Batangas	94	9	3.2	2.2	366	0.5	29.3	34.1	0.72	27
9	Tayabas Bay - Outer	567	25	4.6	29.6	591	0.3	29.3	34.1	0.72	30
10	Inner Tayabas Bay	1532	98	23.1	47.4	156	0.4	29.3	34.2	0.71	34
11	Buenavista, Marinduque	271	16	4.7	15.7	385	0.3	29.1	34.2	0.71	30
12	Torrijos, Marinduque	38	6	1.6	1.9	377	0.3	29.4	34.3	0.71	27
13	North Sibuyan Sea 1	54	6	1.7	57.6	1048	0.3	29.2	34.3	0.71	31
14	San Francisco, Quezon	103	12	3.9	5.6	131	0.4	29.2	34.3	0.71	32
15	North Sibuyan Sea 2	54	7	1.5	11.2	1479	0.3	29.2	34.3	0.71	35
16	Mauban, Quezon	32	2	1.1	2.5	62	0.4	29.0	34.1	0.78	39
17	Cabalete Is.	142	7	2.3	13.9	134	0.3	29.1	34.1	0.80	94
18	Calauag Bay	486	19	5.2	9.3	70	0.5	29.2	34.1	0.78	21
19	Camarines Norte	4762	79	19.6	19.3	60	0.3	29.0	34.4	0.79	37
20	Ragay	552	18	4.4	3.6	168	0.5	29.3	34.5	0.71	68
21	North Burias Island	1043	51	12	48.6	157	0.3	29.2	34.4	0.71	56
22	Sibuyan Sea 3	290	9	2.1	35.0	1036	0.3	29.2	34.3	0.71	36
23	Sibuyan Sea 4	28	6	1.5	94.0	589	0.2	29.2	34.3	0.71	39
24	Sibuyan Sea 5	232	4	1.5	9.8	1019	0.2	29.3	34.3	0.71	40
25	West Burias Island 1	76	11	1.7	3.1	119	0.3	29.3	34.4	0.71	41
26	West Burias Island 2	152	18	5.1	3.1	370	0.3	29.1	34.4	0.71	40

ID	Core Fishing Area	Area (km²)	Maximum lights per night	Mean lights per night	Mean radiance	Mean Depth (m)	Mean chl-a	Mean SST	Mean surface salinity	Mean SSH	Mean MLT (m)
27	Aroroy, Masbate 1	180	19	4.9	5.5	96	0.3	29.0	34.4	0.71	42
28	Masbate Pass 1	338	11	2.4	3.9	555	0.4	29.0	34.4	0.71	43
29	Ticao Island	32	3	1.2	2.2	113	0.7	28.6	34.4	0.71	51
30	Masbate Pass 2	202	10	3.1	3.9	146	0.8	28.7	34.3	0.71	46
31	North Northern Samar	459	13	3.1	3.8	29	0.6	29.0	34.2	0.80	31
32	South Sibuyan Sea	1954	49	13.3	34.9	155	0.4	29.2	34.3	0.71	39
33	Aroroy, Masbate 2	20	6	1.4	1.9	35	0.4	28.9	34.4	0.71	42
34	Nin Bay	55	9	2.7	1.7	22	0.5	29.1	34.3	0.71	43
35	Asid Gulf	568	52	7.1	1.6	12	1.4	29.4	34.3	0.71	49
36	Balud, Masbate	6	3	1.2	13.6	52	0.5	29.3	34.2	0.72	53
37	Visayan Sea 1	2186	50	15.1	28.9	57	0.5	29.2	34.2	0.72	35
38	Southern Masbate	168	7	1.5	3.1	234	0.5	29.0	34.3	0.71	40
39	Samar Sea	2017	35	9.1	3.9	51	0.9	29.9	34.0	0.73	24
40	Visayan Sea 2	108	9	2.3	16.3	29	0.7	29.3	33.9	0.74	12
41	Bantayan, Cebu	35	7	2.2	2.5	12	1.2	29.4	34.0	0.72	19
42	West Leyte	590	8	1.9	1.9	269	0.4	29.6	34.2	0.72	33
43	Pacijan Island	184	14	2.9	1.9	327	0.2	29.8	34.2	0.72	31
44	Poro Island	61	6	1.7	2.0	219	0.3	29.9	34.2	0.72	32
45	Outside Ormoc Bay	258	5	1.4	1.6	170	0.5	29.9	34.2	0.72	34
46	Bato, Leyte	609	11	2.8	10.3	225	0.3	29.6	34.3	0.72	30
47	San Pablo Bay	233	6	1.7	1.7	23	0.9	30.0	34.4	0.80	64
48	Leyte Gulf	182	13	3	1.7	41	0.4	29.9	34.4	0.79	47
49	Panglao	1053	16	2.9	1.6	367	0.2	29.4	34.3	0.72	57
50	San Jose, Antique	183	4	1.4	15.3	702	0.2	29.4	34.0	0.72	40
51	Southwest Antique	747	12	4.4	19.8	1028	0.2	29.5	34.0	0.72	39
52	Iloilo City	1312	32	6.7	18.7	948	0.4	29.3	34.0	0.72	38
53	Cauayan, Negros Occ.	469	30	8.7	35.9	197	0.7	29.2	34.0	0.72	40
54	Southern Negros	932	20	3.4	1.5	227	0.4	29.6	34.2	0.72	40
55	Macajalar Bay	1654	12	2.1	5.1	829	0.5	29.6	34.1	0.71	30

ID	Core Fishing Area	Area (km²)	Maximum lights per night	Mean lights per night	Mean radiance	Mean Depth (m)	Mean chl-a	Mean SST	Mean surface salinity	Mean SSH	Mean MLT (m)
56	Carrascal Bay	77	8	2.4	5.0	22	0.5	30.0	34.3	0.74	40
57	Tandag, SDS	36	6	1.7	1.9	26	0.3	29.6	34.3	0.75	35
58	Sindangan, ZDN	170	26	5	3.3	318	2.2	29.0	34.0	0.70	35
59	Gutalac, ZDN	225	34	6.9	73.4	157	1.4	28.7	34.0	0.70	35
60	Pagadian Bay	267	13	3	1.6	200	0.4	30.1	34.1	0.66	26
61	Tabina, ZBS	44	10	2	1.7	191	0.4	30.2	34.2	0.66	26
62	Dumanquillas Bay	67	7	1.9	1.7	23	0.5	30.6	34.2	0.65	17
63	Moro Gulf 1	16	7	1.9	2.8	15	0.8	30.2	34.2	0.66	20
64	Moro Gulf 2	572	29	5.2	13.8	139	0.2	30.2	34.2	0.66	22
65	Sibuguey Bay	582	21	4	1.9	53	0.6	30.6	33.8	0.65	9
66	West Moro Gulf	2647	112	23.2	47.2	216	0.2	30.4	34.1	0.65	18
67	Basilan Strait 1	654	54	11.6	64.4	191	0.6	29.0	34.0	0.70	30
68	Basilan Strait 2	358	19	3.7	17.2	70	0.6	29.2	34.0	0.67	38
69	West Basilan	248	28	5.3	51.1	53	0.8	29.1	34.0	0.70	30
70	Sulu	4180	219	61.7	75.8	74	0.8	29.0	34.0	0.70	32
71	Tawi-Tawi	2100	90	16	82.4	99	0.6	29.1	34.0	0.72	31
72	Pangutaran, Sulu	121	3	1.2	6.5	20	0.9	29.0	33.9	0.72	32
73	Digos, Davao Gulf	296	10	1.8	1.5	363	0.4	29.9	34.3	0.64	30
74	Southern Sulu 13	190	11	3	19.6	64	0.3	29.9	33.8	0.75	46
75	South Mapun	6068	103	11.9	76.6	74	0.2	29.7	33.8	0.75	55
76	Southern Sulu 7	19	8	1.8	118.2	78	0.2	29.4	33.9	0.75	53
77	Southern Sulu 6	238	24	4.3	119.8	87	0.2	29.4	33.9	0.75	50
78	Southern Sulu 5	150	21	4	130.9	61	0.2	29.4	33.9	0.75	39
79	Southern Sulu 3	499	16	2.9	12.1	37	0.3	29.6	33.7	0.76	40
80	Southern Sulu 4	538	38	4.7	112.0	79	0.2	29.4	33.9	0.75	47
81	Southern Sulu 2	700	44	5.3	103.3	70	0.2	29.4	33.7	0.76	49
82	Southern Sulu 1	634	33	5.2	140.1	105	0.2	29.4	33.8	0.76	40
83	South Balabac 2	122	19	2.3	11.7	49	0.3	29.5	33.6	0.76	33
84	South Balabac 1	287	19	3.4	116.4	115	0.2	29.4	33.6	0.75	21

ID	Core Fishing Area	Area (km²)	Maximum lights per night	Mean lights per night	Mean radiance	Mean Depth (m)	Mean chl-a	Mean SST	Mean surface salinity	Mean SSH	Mean MLT (m)
85	South Bugsuk Island	540	29	4.2	114.2	110	0.2	29.4	33.7	0.76	41
86	East Bugsuk Island	270	27	3.5	90.9	105	0.2	29.5	33.7	0.76	44
87	South Bataraza	196	13	3.2	3.2	11	0.6	29.6	33.5	0.77	26
88	West Balabac	458	44	5.7	119.9	90	0.2	29.5	33.6	0.75	22
89	West Bataraza	266	20	3.4	104.3	71	0.2	29.5	33.6	0.75	25
90	East Bataraza 2	434	34	3.7	62.0	74	0.2	29.5	33.8	0.76	38
91	East Bataraza 1	35	4	1.5	2.0	13	0.4	29.5	33.7	0.76	31
92	East Brookes Pt 2	9	4	1.3	3.6	24	0.3	29.5	33.8	0.75	44
93	Rizal, Palawan	109	17	3	118.5	69	0.2	29.7	33.6	0.75	15
94	Narra, Palawan	1351	25	6.6	4.5	48	0.4	29.5	33.9	0.76	38
95	Quezon, Palawan	1122	30	4.8	11.3	51	0.2	29.6	33.6	0.76	20
96	West Aborlan	59	6	1.6	12.7	44	0.3	29.5	33.4	0.78	23
97	West Puerto Princesa 1	112	10	2.4	20.8	29	0.3	29.3	33.4	0.78	20
98	West Puerto Princesa 2	107	11	3.1	106.3	59	0.2	29.5	33.5	0.77	28
99	Honda Bay	73	3	1.4	9.4	38	0.3	29.5	33.9	0.76	36
100	Outside Ulugan Bay	142	11	2.3	19.0	47	0.6	29.2	33.5	0.78	34
101	Imuruan Bay 2	105	5	1.5	3.2	33	0.8	29.5	33.6	0.78	37
102	Northwest Palawan 1	2582	77	11.8	83.8	74	0.2	29.5	33.6	0.77	31
103	Northwest Palawan 2	14	6	1.9	114.8	78	0.3	29.4	33.5	0.77	36
104	Imuruan Bay 1	80	5	1.5	2.5	33	0.6	29.2	33.6	0.78	37
105	Roxas, Palawan	135	24	3.3	87.1	85	0.2	29.3	34.0	0.76	35
106	Northeast Palawan	23215	227	42.4	91.9	87	0.3	29.1	33.8	0.75	25
107	West El Nido	389	25	4.9	165.6	71	0.2	29.4	33.6	0.77	25
108	West Calamianes 5	66	9	2.5	132.0	186	0.2	29.7	33.7	0.76	19
109	West Calamianes 4	56	9	2.4	124.6	77	0.2	29.8	33.7	0.76	27
110	West Calamianes 3	964	77	9.6	105.5	69	0.3	29.5	33.7	0.77	30
111	North Linapacan	46	8	2.3	79.0	67	0.3	29.4	33.6	0.78	32
112	West Culion 2	61	8	2.6	18.8	62	0.4	29.3	33.6	0.78	24
113	West Culion 1	134	8	2.4	22.9	54	0.3	29.5	33.5	0.78	22

ID	Core Fishing Area	Area (km²)	Maximum lights per night	Mean lights per night	Mean radiance	Mean Depth (m)	Mean chl-a	Mean SST	Mean surface salinity	Mean SSH	Mean MLT (m)
114	West Calamianes 2	78	11	2.6	49.8	54	0.2	29.7	33.7	0.77	24
115	West Calamianes 1	58	7	2.2	38.6	77	0.2	29.7	33.7	0.76	16
116	West Busuanga	44	10	2.3	19.5	52	0.2	29.6	33.6	0.77	20
117	North Busuanga	1127	48	6.6	24.6	86	0.2	29.9	33.8	0.76	24
118	Mindoro Strait 6	39	9	1.9	36.0	133	0.2	30.0	33.7	0.76	18
119	Mindoro Strait 5	24	6	1.8	23.6	122	0.2	30.1	33.7	0.76	20
120	Mindoro Strait 2	52	15	2.3	8.7	160	0.2	30.1	33.7	0.76	21
121	Mindoro Strait 3	177	30	2.8	17.4	138	0.2	30.1	33.8	0.76	22
122	Occidental Mindoro	4754	185	31.5	2.1	1276	0.2	29.9	33.8	0.75	25
123	Mindoro Strait 1	69	10	2	2.9	253	0.2	29.8	33.8	0.75	26
124	Mindoro Strait 4	112	17	2.4	1.7	349	0.2	29.6	33.8	0.75	26
125	San Jose, Mindoro	215	20	4.3	1.8	343	0.3	29.5	33.9	0.74	26
126	Mindoro Strait 7	81	7	1.9	1.8	602	0.2	29.3	33.9	0.74	26
127	Pandarochan Bay	55	5	1.5	1.8	50	0.7	28.8	34.1	0.72	25
128	Soguicay Bay	61	8	1.6	2.2	154	0.3	28.7	34.2	0.72	35
129	Mansalay, Mindoro	168	10	2.7	2.7	151	0.4	28.9	34.2	0.72	32
130	Bulan, Sorsogon	16	3	1.3	1.4	45	0.8	28.7	34.4	0.71	67
131	Semirara Is. 1	16	6	1.6	3.6	47	0.4	28.8	34.1	0.72	38
132	Semirara Is. 2	16	5	1.5	8.4	5	0.4	28.9	34.1	0.72	38
133	Sabang, Palawan	50	7	1.8	21.0	47	0.6	29.2	33.5	0.78	31
134	Mabini, Bohol	53	9	2.2	1.7	25	0.4	29.4	34.3	0.72	37